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EDITOR

WILLIAM ALPHONSO MURRILL

Volume XIII, 1921

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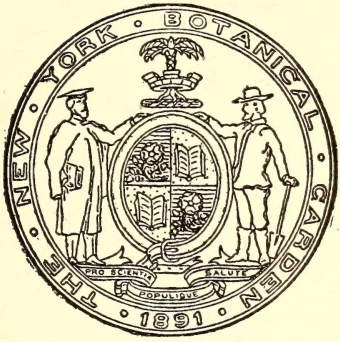

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MYCOLOGIA

VOL. XIII . JANUARY, 1921 No. 1

STUDIES ON PLANT CANCERS—II

THE BEHAVIOR OF CROWN GALL ON THE RUBBER PLANT (*FICUS ELASTICA*)[1]

(WITH PLATES 1 AND 2)

MICHAEL LEVINE

Smithsonian Institution FEB 7 1921 National Museum

Toumey (1900) in studying the effects of crown gall on the host pointed out the destructiveness of this disease on deciduous trees. He gave an adequate picture of the developmental stages in the growth of the crown gall tissue on the almond. He contends that the period of growth of the crown gall is definite and usually extends over the growing season; after which time the gall dies, falls out, leaving an open wound. In the following spring a new crown gall is formed on the margin of the old wound which in turn dies and increases the area of the lesion, so that it weakens the tree and causes it to break off in a wind, thus killing it. It appears from Toumey's study that death is the result of a mechanical effect of the crown gall on the tissue of the host in no way similar to the toxic effects that the cancerous growth has on the animal or human being.

Hedgcock (1910[1]) in his field studies of the effect of crown gall on grape showed that the crown gall stunts the plant and that when the galls occur on the stem under the ground they commonly decay, killing the adjacent tissue and often killing the vine above the point of attack. Whether the decay is directly brought

[1] From the Cancer Research Laboratory, Montefiore Hospital, Dr. Isaac Levin, Chief. The first paper was published in Bull. Torrey Club 46: 447–452. *pls. 17, 18.* 1919.

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about by *Bacterium tumefaciens* Hedgcock does not state. He claims however with Toumey that the galls die annually. In a later study (1910[2]) of crown gall on the apple he maintains that the destructive effect of this disease is overrated.

Smith (1911–12) in his extensive studies on crown gall and its resemblance to animal cancer shows that the physiological effects of these tumors vary from species to species and also within the species and are generally less pronounced and speedy than one might expect. He holds that it is difficult to show conclusively that the substances produced in the tumor by the parasite are absorbed and act as slow poisons. This is especially difficult in view of the fact that the galls are often soaked by rains and become infected with other parasitic and saprophytic organisms.

Levin and Levine (1918–20) in a report on the malignancy of the crown gall and its analogy to human cancer pointed out that a number of the phenomena in both diseases are analogous. They contend that the neoplasms in plants produced by *Bacterium tumefaciens* are sometimes benign though some are true malignant growths. The latter generally dwarf the plant so affected and cause necrosis of the tissue above and below the gall.

These studies and those of Smith's and other workers were carried out in annuals, biennials or deciduous trees in which the period of growth of the host as well as the crown gall is normally interrupted. The difficulty in determining whether toxins are present in such cases is made more difficult by the intervention of natural death, caused by changes in temperature and its concomitant factors, and second, by the occurrence of infections caused by fungi and even insect grubs, the eggs of which are deposited in the soft tissue of the young crown gall.

The purpose of this report is to bring forward further evidence on the malignancy of the crown gall experimentally induced on mature evergreen perennials such as the common rubber tree, *Ficus elastica.* In such plants where the growth is rather active all the year round, when kept under uniform, green house conditions, the effect of the crown gall organism and the neoplastic growth on the host can be kept under observation for an extended period. Drenching rains and destructive insects are

avoided and very often other parasitic and saprophytic fungi. In this way and in such plants as *Ficus elastica* it is possible to show definitely whether and in what degree the crown gall has an injurious effect upon the adjacent normal tissue of the host. It must be remembered however that while transportation of the materials elaborated by the cancer cells of the animal is in some degree limited, this is much more the case in plants.

I have found some evidence of injurious effects spreading from a gall upwards and finally killing the stem above the point of inoculation. This was the result in every case (10 branches) with two exceptions. In the first the signs of death are only now, 14 months after inoculation were made, making their appearance. In the other case described below, the stem, it appears, was cut off for examination too soon.

In no case was there any evidence that the death of the stem above the gall was due to the obstruction of the sap flow or water supply. Toumey's results do not suggest the possibility of any such direct mechanical disturbance on the part of the gall. I will describe briefly a number of cases observed.

Material and Observations.—Through the courtesy of Dr. S. Wachsmann, director of the Montefiore Hospital, a number of rubber trees (*Ficus elastica*) were placed at my disposal. These plants were growing in large boxes and were kept indoors during the winter months in a basement room well lighted and ventilated. In the summer these plants were moved out on the campus of the hospital. These plants make almost as much growth during the winter as they do during the summer. Various parts of these plants were inoculated with *Bacterium tumefaciens,* labeled and then examined from time to time. It was found that within a month indications of a crown gall made their appearance in the part of the plant inoculated.

Figure 1 represents one of the trees during the month of January used in this study. The terminal buds are opening and the moderately green glistening apical leaves show evidence of an active condition of growth. The plant shown in figure 1 with five others of equal size were inoculated on July 28, 1919, by pricking the tissue with a steel needle that had been previously

dipped into a culture of *Bacterium tumefaciens.* As few as five pricks of the needles with the crown gall organism were found to be sufficient to produce a visible neoplasm in a month's time. A careful scrutiny of this picture reveals a number of galls at the internodes of several branches (Fig. 1, *a, b*) on the mid-vein of an old leaf (Fig. 1, *c*) and on one of the main branches (Fig. 1, *d*). Where the needle perforated the tissue a crown gall was formed on both sides of the stem or the leaf. No less active were the growths that were produced on the trunk of the tree (Fig. 1, *d*). The galls formed are of the characteristic type described by Toumey, Smith and others. They are always firm, yellowish in color and covered with brownish patches when young and become dark brown in color and of a woody consistency with age, as we shall see below.

The crown gall, at this stage, as far as can be seen, has no specially injurious effect upon the host. The terminal buds of the plant are actively growing and there appears to be no signs of dwarfing of the branches, nor any indication of fascination of the internodes above the region of inoculation such as those reported by Smith, and Levin and Levine for *Geranium, Ricinus,* etc.

Figure 2 represents a branch from another rubber tree which had been inoculated seven months previously on the second internode. The crown gall has grown extensively, covering one half of the circumference of the stem. The surface is dark brown in color, highly convoluted, indicating a number of centers of peripheral growth. The mass is hard and some parts of the surface appear to be dead. The branch however has grown considerably as shown by the number of internodes above the crown gall. (See Figs. 2 and 3.) In June, 1919, it was noted that the terminal bud was small and dark green in color, and showed no signs of growth. This was true of a number of other branches which had been inoculated for the same length of time. The control branches that were similarly treated with a sterile needle had long greenish buds, many of which were opening. This condition suggested at once the possibility of mechanical interference of the crown gall with the water supply of the plant due to partial destruction and possible occlusion of the fibrovascular bundles,

but cross and longitudinal sections of this gall made much later showed this assumption to be incorrect as is further described below. It is obvious at once however that there is some other cause of death than the cutting of the water supply, since in that case, the dying would progress from the tip downward.

Twelve months after inoculation. Figure 3 represents the same branch shown in figure 2 on December, 1919, approximately 12 months after the inoculation had been made. The crown gall has almost girdled the stem encircling 7/8 of the stem's circumference. The leaves above the crown gall have turned black and fallen off while those below are turning a yellowish brown. The major portion of the stem above the gall is dead, the injury progressing from the gall upward so that at the time the photograph was made the top of the stem (Fig. 3) was still green and showed indications of being alive. A cross section through the middle of this crown gall appears in figure 4 and shows that the crown gall tissue has become fully differentiated and thus further supports the contention of Toumey and Hedgcock that the crown gall growths are annual and Levin and Levine's views that these growths are unlike animal cancers in that they are limited in growth and become differentiated. The wood fibers and parenchymatous cells of which the crown gall is composed are dark brown on the interior of the gall as they are on the surface. The vascular elements are distorted and nodular on the periphery of the tumor where their antecedents were undoubtedly centers of rapid cell division before they became differentiated and old.

Approximately one half of the original cylinder made by the fibrovascular bundles is destroyed and replaced by crown gall tissue. The tissue in the center of the crown gall is dark in color, watery and is apparently disintegrating. The remaining half of the wood cylinder appears to be undistributed and undoubtedly is mechanically fit to carry sap, as evidenced by the still turgid condition of the top of the branch as shown in figure 5. This figure represents a longitudinal section of the upper part of the stem including the upper part of the crown gall. There appears to be only a partial destruction of the wood fibers in the region of the stem occupied by the lesion as seen in the

cross section to the left of the figure. The wood and pith are apparently normal structurally though physiologically dead.

A later state in the necrosis following the inoculation of *Bacterium tumefaciens* is shown in figure 6 photographed eleven months afterward. Here again the inoculation was made at one side of the stem in the third internode with a needle dipped into an emulsion of the crown gall organism. In this late stage the growth does not completely girdle the stem, yet two months previously the leaves fell off and the stem became discolored and finally died. The crown gall and the stem above the gall also died. A short portion of the stem immediately below the gall at the time of the photograph was rapidly undergoing similar changes. The gall in this case again shows all the characteristics of the typical crown galls referred to above. The outer surface is dry and woody and is markedly nodular. In a longitudinal section of this gall we find the region near the stem slightly moist, darker in appearance and invading the wood cylinder (Fig. 7). A large portion of the wood cylinder is intact and appears to be functional. There again, it appears as if death was caused by *Bacterium tumefaciens* or the crown gall cells rather than by the interference with the transportation system caused by the destruction on the invasion of the fibrovascular bundles.

Figure 8 represents a gall 12 months old which has caused no injury to the stem either above or below the gall. Growth is continuing normally. The inoculation was made in two opposite sides of the branch. The crown gall that appears in front on the stem "B" and "C" was produced by inoculating an axillary bud region. The lower gall, "A," was obtained by inoculating an internodal space on the opposite sides of the stem. The lower growth which appears as two separate tumors on opposite sides of the stem consists of one continuous mass of tissue encircling one half of the circumference of the stem. The growth has a distinctly tubercular structure. It is dark brown in color, hard and dry, and apparently dead. The upper crown gall which is on the surface of the stem, as mentioned above, extends for a distance of nearly one half of the circumference of the stem also. To the left it developed into a more or less uniformly globular growth through which two branches have grown.

We may turn now to consider the cases in which no evidence of injurious effects of the gall in tissue above and below it in the stem have yet appeared. In all, I have observed two such cases as mentioned above against ten in which death of the region above and below the gall or both occurred.

It is natural to suspect in view of the statements of the authors quoted that the injurious effects I have observed may be due to the presence of some additional infection or to some special direct physical effect of the crown gall on the rubber tree. I am however convinced that this is not the case.

As in the case of *Bryophyllum* (Levine 1919), *Bacterium tumefaciens* does not cause the formation of embryomata when inoculated into *F. elastica* in a region where embryonic cells are to be expected. At the time this photograph was made, twelve months after inoculation, the upper gall was still active although parts of it were beginning to distintegrate. The stem above the gall appears as noted to be entirely unaffected and in good physiological condition. A cross section of the stem made at the level indicated by the line "AA" shows complete disorganization of more than one half of the wood cylinder. The remaining half is not unlike the apparently healthy portion of the wood shown in figure 4. A photograph of the cut end of the stem at the level of "BB" (Fig. 8) is shown in figure 9. Here little of the vascular cylinder appears to be invaded by the crown gall tissue. At this level the great mass of the crown gall seems to have developed from the cortical layer of the stem only and has not, at this time, affected the central cylinder.

The gall from which the branches "Y" and "Z" appear (Fig. 9) is unlike all other crown galls so far described in that almost its entire surface is smooth and not tubercular; it is covered with small brown corky patches. The lower left side of the gall in the picture shows the typical crown gall convolutions.

A section still higher up on the stem made at the level indicated by the line "CC" cuts through this smooth gall at a point near the origin of the branches "Y" and "Z" (see Fig. 10). An abundance of milk comes from the entire surface above the dark area of the crown gall shown in this figure. No invasion

of the central cylinder by the crown gall tissue appears. There is, however, a slight hyperplasia of the wood. The fan-shaped vascular elements in the gall seem to be running into the branches "Y" and "Z" from "X." The gall in this case may be compared to the so-called benign tumors (Levin and Levine, 1918). The character of the tissue of this neoplasm does not differ from that of a malignant crown gall. It seems obvious that the death of the crown gall is in general a result of merely mechanical conditions. The gall may be insufficiently supplied with food and water and dies because it fails to establish an adequate connection with the conducting system of the host. It is most likely that this is true of the almond crown gall described by Toumey.

Bacterium tumefaciens from stem and crown gall. The possibility that another organism as well as *Bacterium tumefaciens* is present and is responsible for the destruction of the stem apex as shown in figures 3, 5, 6 was tested in the following manner. Small pieces of the interior of the crown gall shown in figures 3 and 6 were carefully removed with a sterile knife and placed in tubes of beef agar. In two days the surfaces of the agar on which the inocula were resting became covered with a hyaline, whitish yellow colored schizomycete which in general appearance is not unlike that of *Bacterium tumefaciens*. Similar results were obtained by planting pieces of the stem from above the crown gall after being superficially sterilized by immersing in a weak formol solution. In all tubes the organisms were more or less alike in their superficial appearance. In several beef agar cultures the hyphae of a mold made their appearance. The presence of the mold we consider accidental contamination. Molds at any rate are not known to be parasitic on and to cause death of the rubber tree.

It appears from this that the organism is carried to parts removed from the gall but owing to its depauperate condition is unable to influence the production of a new growth.

The organism obtained in these cultures were inoculated into the tissue of young growing geranium plants and young shoots of the rubber trees. Crown galls appeared within two months after inoculation. The growths were much smaller than those

obtained by inoculating young geraniums and branches of a rubber tree with a known culture of *Bacterium tumefaciens.* This supports the contention that the bacteria in the distant parts of the stem bearing a crown gall are of a less virulent strain.

SUMMARY

1. *Bacterium tumefaciens* inoculated into the apical internode of the branches, into the leaves, or main stem of the rubber tree, *Ficus elastica,* stimulates the development of a neoplasm in the region of inoculation of a benign or malignant nature. The crown galls so formed, in this plant, are of two kinds, one in which growth is uniform and appears to be a swelling, the other is the characteristic convoluted type indicating a peripheral growth of isolated nodules.

2. The early stages in the development of the crown gall in *Ficus elastica* does not interfere with the life of the plant as a whole nor does it interfere with the growth of the inoculated branches.

3. The crown gall in *Ficus elastica* after a number of months of active growth becomes hard and dry and finally dies. This is associated with the differentiation of the tissue which converts the gall into a mass of parenchymatons cells and nodules of woody fibers. The central portion of the crown gall which generally lies near the woody cylinder disintegrates.

4. The invasion of the stem by the new growth does not destroy the entire conducting system of the stem, yet that portion of the stem above the gall dies as well as considerable portion of the stem below.

5. Cultures made from pieces of the crown gall and stem above the gall yield only a schizomycete which in appearance is not unlike *Bacterium tumefaciens* and which when inoculated into the stem of young geranium and rubber plants produce crown galls in the region of inoculation.

6. It is possible that the crown gall cells or the crown gall forming organisms are responsible for the progressive necrosis of the stem from the gall upward and downward. The death of the plant due to crown gall is at least suggestive of the death caused by malignant growths in animals.

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EXPLANATION OF PLATES 1 AND 2

Fig. 1. Represents the type of *Ficus elastica* used in these experiments. The galls in the various parts of the plant *a, b, c,* and *d* are the result of inoculating them with a culture of *Bacterium tumefaciens,* five months previously.

Fig. 2. Apical portion of a branch showing a large crown gall seven months after inoculation in the second internode. The gall does not seem to have interfered with the growth of the stem; several internodes having been added in the interim. (× ½.)

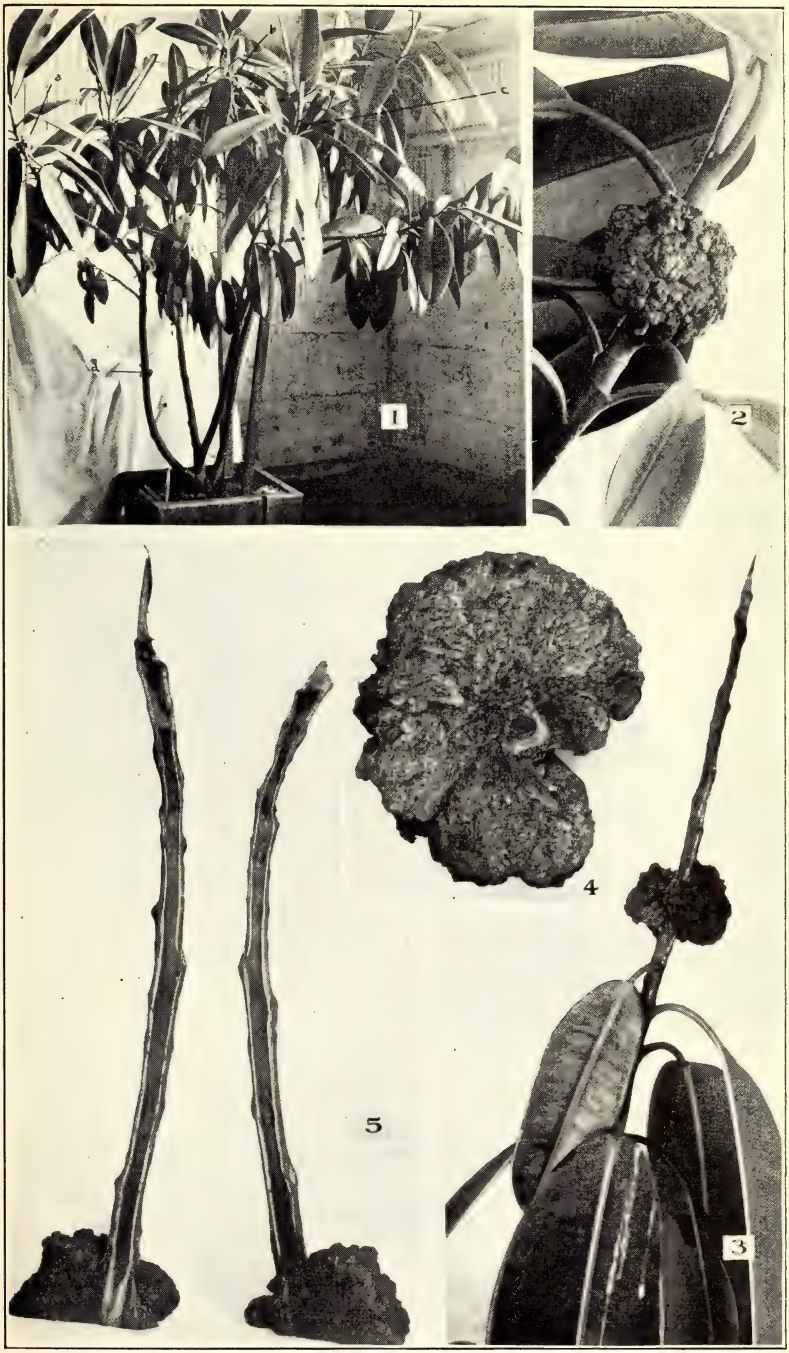
Fig. 3. Same branch twelve months after inoculation. The leaves above the gall have dropped off. The stem is discolored, dry, and dying progressively upward. The tip is still green and alive. The gall is hard, dry and dead. (× ¼.)

Fig. 4. Cross section of the stem through the gall shown in figure 3. The wood cylinder is only partially destroyed by the invading gall. The portion of the crown gall near the central cylinder is soft and disintegrating.

Fig. 5. Longitudinal section of the upper portion of the same stem. The portion near the gall is dry, brown and dead, while the apical internode and bud are still green and alive.

Fig. 6. A branch of *Ficus elastica* in which the gall and the stem above and below the gall is dead; the inoculation having been made twelve months previously.

Fig. 7. Longitudinal section showing invasion of the crown gall destroying a considerable portion of fibrovascular bundles. The invading portion of the gall is soft, spongy and disintegrating.



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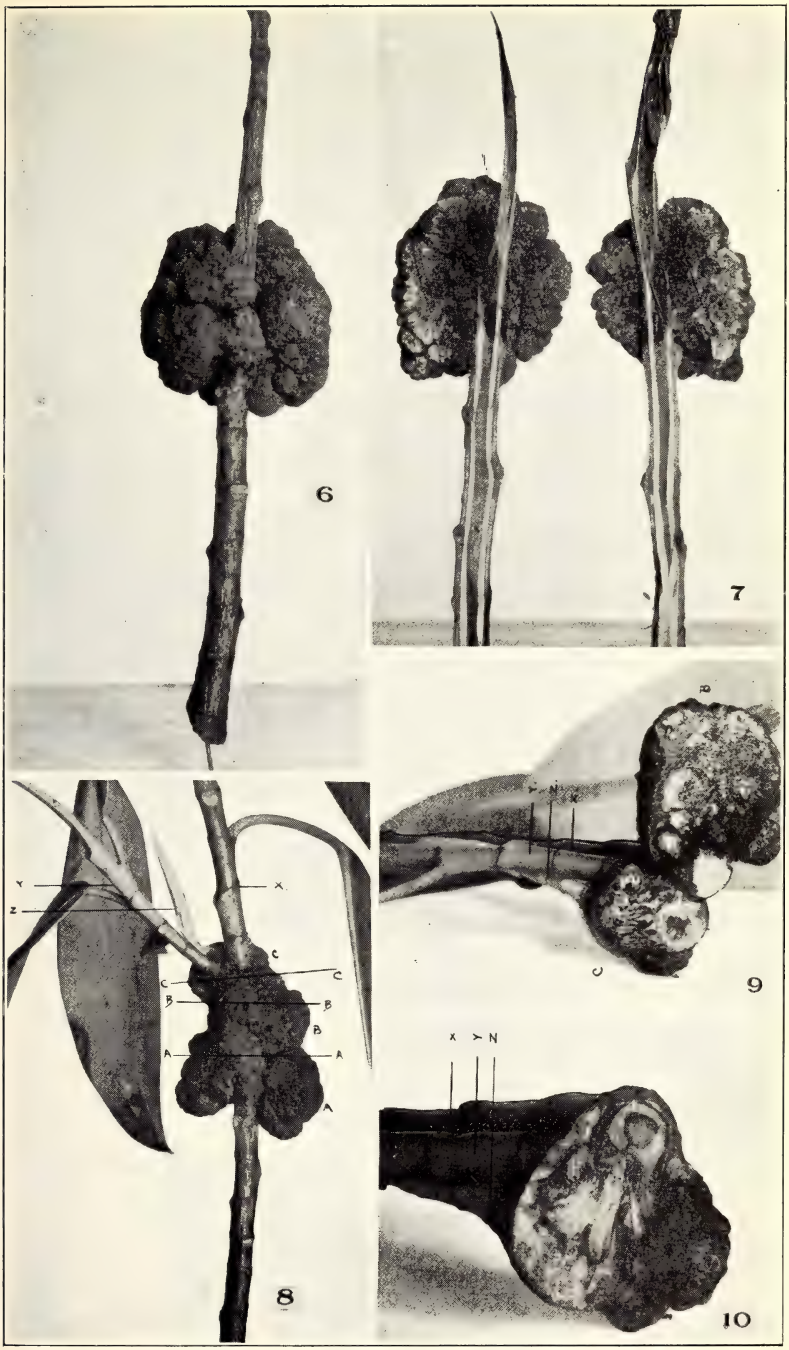

BACTERIUM TUMEFACIENS ON FICUS ELASTICA

Fig. 8. A branch of *Ficus elastica* actively growing twelve months after having been inoculated with *Bacterium tumefaciens*. Two galls formed "A," and "B," "C," on opposite sides of the stem showing the smooth and nodular types of crown galls. Two branches are growing through the smooth crown gall.

Fig. 9. Cross section of stem between the upper and lower crown galls corresponding to level indicated by the line "BB" in figure 8. The gall to the left is of the smooth kind, being covered by corky patches.

Fig. 10. Cross section higher up on the stem corresponding to the level indicated by the line "CC" in figure 8. Shows large brown necrotic area and the undisturbed cylinder of the main stem "X" with bundles of fibers going to branches "Y" and "Z."

NINETEEN YEARS OF CULTURE WORK[1]

J. C. Arthur

A series of culture experiments with the Uredinales was begun by the writer in 1899, and continued under the auspices of the Indiana Agricultural Experiment Station without interruption until 1917, making nineteen consecutive years in which this method of research was consistently pursued. The results of the work were embodied in fifteen reports, printed in the Botanical Gazette, Journal of Mycology, and Mycologia. It is now proposed very briefly to review the work, in order to set forth some of the objects accomplished, and especially to point out the more important of the changing conceptions of the problems forming the ground plan on which the work was projected.

The cultures were not undertaken as part of a distinct thesis or circumscribed problem. They were rather the aids in a general taxonomic study of American rusts, which was directed toward supplying a technical description as complete as possible for every species of Uredinales in North America recorded in literature or known to the writer. This ambitious undertaking was definitely begun sometime in the nineties at the invitation of the editors of the North American Flora.

Beginning with my first taxonomic work on the rusts in 1882 it had seemed to me highly desirable for the purposes of a full technical description of species, that every part of these microscopic plants, capable of supplying diagnostic characters, should be uniformly considered, quite as much as are the stems, leaves, inflorescence, flowers, and fruit of higher plants, and that every means should be taken to arrive at a clear understanding of the identity and relationship of the various forms and species. No effort should be spared, it was believed, to make the name applied to any form embrace also the transformations and variations

[1] Contribution from the Botanical Department of Purdue University Agricultural Experiment Station.

which that form undergoes in passing through its whole life cycle. Many rusts are commonly collected in only one or two stages of their development, or the several stages are taken as independent objects, and to grow such rusts so as to keep them under direct observation and be able to note the succession of stages seemed highly desirable, and especially so for the heteroecious species which pass their gametophytic and sporophytic stages upon wholly unlike and unrelated hosts. It was natural, therefore, to direct chief attention, especially at first, toward unraveling the tangle of heteroecious forms.

Nobody knew how many rusts were to be found on the North American continent and its islands. There were possibly a thousand or more names in existence, but how many of these names applied to single and independent life cycles, and how many to parts of cycles, or were synonyms, no one had attempted to say. It was, in fact, only with the existing names that I had to do. It was no part of my problem to discover new species, or to give new names, either in preparing manuscript for the North American Flora, or in conducting cultures, except in so far as these were required for the systematic development of the work. Many longer or shorter excursions were made during the progress of the cultures, some of them a thousand miles or more, but they were all for the purpose of making field observations upon known species, and in no case for making discovery of new species. The new species that were found were an incidental result.

The first year of the culture work, that of 1899, was very encouraging, and developed no particular difficulties calling for solution. So far custom was followed in the application of names, and it had not been necessary to apply any formula to decide what constituted a species. The assumption that forms on the same or closely related hosts, having no striking morphological differences, were of one species seemed a sufficient hypothesis, and the corollary necessarily followed that cultures would show the range of hosts for each species, as well as serve to demonstrate the stages and spore-forms in the life cycle. Certain features in connection with the common Euphorbia rust did indicate that difficulty might be found in the application of the

corollary, and this indication became more pronounced during the year following.

In 1902 three species of Euphorbia of unlike appearance and growth habits were found to bear non-interchangeable rusts, which were tentatively considered to present races of *Uromyces Euphorbiae* C. & P., and with the more confidence because no well-defined morphological distinctions could be detected. Subsequent studies strengthened this view of races, and the idea of races from this time on was constantly kept prominently in mind. The attempt to evade or simplify taxonomic and cultural difficulties by treating such races or biological strains as species, as Tranzschel[2] subsequently did with these same Euphobia forms was not favored.

It was also in 1902 that the Helianthus rust was grown with indication of races, developed further in the following year, and brought to a climax in 1904, with the conclusion that a number of more or less well established races occur in *Puccinia Helianthi* Schw., having *Helianthus annuus* as a bridging species, following the lead of Marshall Ward[3] in his study of the brome rusts. No further considerable effort was made to study races in autoecious species, or to pick out bridging hosts, as it was held that to ascertain the identity of species was as great a task as could be undertaken in this series of cultures, and that studies leading to the separation of a species into varieties, races, forms, or other subclasses, although of much biological and often of great economical interest, must be left for other time and hands.

The problems of the Carex rusts came early into view. In 1901 and 1902 the three remarkable co-species, having telia on various species of Carex and aecia on species of Aster, Solidago and Erigeron respectively were repeatedly grown from telial material, and were called *Puccinia Caricis-Asteris, P. Caricis-Solidaginis,* and *P. Caricis-Erigerontis.* As no single collection of teliospores was found that would infect more than one of the genera named, the forms were tentatively considered to be species and given distinctive names, followng the brilliant cultural methods of Klebahn in Germany, Plowright in England, and

[2] Ann. Myc. 8: 1–35. 1910.

[3] Ann. Myc. 1: 150. 1903.

others, although a careful comparison of the three forms made it seem "not improbable that the three represent more correctly the biological variations of one species," as was stated at the time. In the further study of these forms it was thought that the telial stage might be found to be restricted to certain species of Carex, or to particular sections of the genus, as was believed to be true of the European Carex rusts, which assumption in the case of the American forms, however, could not be established in any definite way. The hosts were shown finally to be even less restricted than supposed, as the Aster form was eventually carried over to Euthamia for its aecia and to Dulichium for its telia.

The necessity soon became acute to find criteria by which to judge of the standing of species among the rusts, and all the more so because the manuscript was now under preparation for the North American Flora. It was soon decided that, for the purposes of the Flora, morphological characters must be the final test for species. Yet for purposes of study outside of taxonomy it might be serviceable and desirable to maintain the so-called biological or physiological species in any rank desired, but they ought not to be recognized as species proper in taxonomic classification. Consequently in 1912 the three Carex forms were combined with certain European forms under the name *Puccinia extensicola* Plowr., a name which has been supplanted by *P. Asterum* (Schw.) Kern, since the cultural series closed. Furthermore, the cultures of 1913 disclosed that *P. vulpinoidis* with its covered telia had its aecia on Solidago, and was a part of this same species heretofore known only with naked sori, making the much emphasized character of covered telia a secondary one to be associated principally with the host.

Thus the idea of species among the rusts grew into a far more definite, although more complex form, than could have been possible without the aid of cultural studies. A liberal view was now also required regarding hosts, and also the stress on certain morphological characters called for modification, but the end was not yet.

In 1910 a number of cultures with the Carex rust, *Uromyces perigynius,* revealed a remarkable parallelism between this species

and *Puccinia extensicola.* Aster and Solidago races came to light, not however quite so well stabilized in some instances as with the corresponding Puccinia races, for in one case sowings of teliospores from the same Carex collection were made to grow on both Aster and Solidago. The two species, one of Uromyces, the other of Puccinia, were subjected to an extensive microscopical study, and no marked differences could be found between their several corresponding spore-forms, except in the septation of the teliospores. This unity of structure had already been observed regarding the aecia and aeciospores when a preliminary culture of the Uromyces was made seven years before. From the microscopical evidence, united with much collateral evidence, the following statement was made in the discussion of 1910, which holds true to the present time: "As the aecia and uredinia of the two groups [of host-races], one under the genus Puccinia and the other under Uromyces, are indistinguishable, and as the teliospores of the Uromyces agree with the one-celled spores of the Puccinia [mesospores] and also with the two-celled spores in all characters except number of cells and consequent length of spore, the former doubtless are morphological races of the latter. Relationship could be shown better by putting all of these forms under one specific name, and designating the several races by varietal names. But in the present state of taxonomy of the rusts it is more convenient to dispose of them under the two genera: *Puccinia* and *Uromyces.*"[4]

If any further illustration were needed to show that Puccinia and Uromyces were not only parallel genera but actually identical, it was supplied by the cultures of the following year, 1911. During this season successful cultures on *Atriplex hastata* of both *Uromyces Peckianus* and *Puccinia subnitens,* each grown from teliospores on the grass, *Distichlis spicata,* obtained from widely separated localities, gave rise to aecia that appeared to be indistinguishable. A morphological study of these two so-called species has been reported by C. R. Orton in his article on "Correlation between Puccinia and Uromyces,"[5] in which he finds a

[4] Mycologia 4: 22. 1912.
[5] Mycologia 4: 199. 1912.

slight difference in size of the urdiniospores, and, of course, in the teliospores a difference in number of cells and consequent size. He points out, however, that these differences are such as are to be expected in other similar cases. The comparison of these two forms of Distichlis rust, as to morphology, hosts and distribution, is an interesting topic, which need not be pursued further here.

If the Carex-Aster-Solidago-Erigeron studies supplemented by studies with the Distichlis rust, opened up new views of the species question in relation to host influence and teliosporic dimorphism, so did the Carex-Ribes studies disclose new views in another direction. The first cultures were in 1901. As the results of sowing teliospores on Ribes gave peculiarly small and pale aecia, it was thought that an unrecognized species had been found, which was called *Puccinia albiperidia.* Whether this form was distinct from the common Carex-Ribes rust of the fields, distinguished as *P. Grossulariae,* and whether American forms were distinct from European forms, of which Klebahn had recognized five, were questions which received attention from year to year as opportunity permitted. In this study Dr. Klebahn graciously consented to lend assistance, and during the two seasons of 1904 and 1906 made cultures at Hamburg, Germany, from telial material supplied by the writer.

Just as the problem seemed solved, and Dr. Klebahn[6] and myself had independently arrived at the conclusion that in both Europe and America only one heteroecious species occurred, which possessed a number of strains or races, it was discovered by C. R. Orton,[7] while assisting with the rust studies, that the original material of *P. albiperidia* on*Carex pubescens,* as well as that on a number of American species of Carex similar to *C. gracillima,* possessed urediniospores with only one basal pore, in part at least, instead of the usual three or four equatorial pores. Again the Carex-Ribes rusts of Amercia seemed to fall into two species, not based on differences in the aecia this time, but on differences in the urediniospores. From 1910 onward the question in this connection was whether or not the same species of rust

[6] Zeits. Pflanzenkr. **17**: 132–134. 1907.

[7] Mycologia **4**: 14, 200. 1912.

could possess urediniospores partly with one basal pore and partly with three or four equatorial pores. The answer involved the value and application of pore characters in defining species. After special search,[8] which led to both kinds of urediniospores being found repeatedly in the same sorus, although for the most part they occurred in separate sori, it was concluded that only one species of rust was under consideration, but with morphological as well as physiological races, not well delimited.

It seemed probable, furthermore, that the previously described, one-pored form of Carex rust, known as *Uromyces uniporulus* Kern, was a race also belonging to the Carex-Ribes species, but it was not possible to test the matter by cultures. In this connection it is interesting to note, and provocative of speculation, that there is no form yet known with three- and four-pored urediniospores belonging under Uromyces in the Carex-Ribes aggregation, to make the parallelism with its Puccinia form complete.

In 1917, the last year of the culture series, the principle of basing species upon morphological characters, with a greater or less degree of mobility in interpretation, was further illustrated by the case of the Spartina rust, *Uromyces Polemonii* (Peck) Barth., which it was found could be segregated into four races,[9] separable by small but appreciable differences in morphological characters of both aeciospores and teliospores, and by wholly unrelated aecial hosts, and further reinforced by some differences in habitat and geographical distribution. The correlated Puccinia-form for this common and widely distributed American rust is that of *Puccinia Distichlidis,* so-called because the type collection was incorrectly labelled as on Distichlis instead of on Spartina. Its range and aecial hosts, so far as known correspond to only one of the four Uromyces races.

At the time the culture work began the subepidermal rusts occurring on wild grasses in America with few exceptions, passed under the name of *Puccinia rubigo-vera,* along with part of the similar leaf rusts of cereals. No criteria had been found for distinguishing them, not even those which had received special

[8] Mycologia **7**: 67–69. 1915.

[9] Mycologia **9**: 309–312. 1917.

names, and every effort was consequently put forth to make headway into this obscure maze of forms. The first success was in 1902 with a form on *Elymus virginicus* and aecia on Impatiens, which became *Puccinia Impatientis* (Schw.) Arth. The work opened up slowly. In 1903 a false move was made in connection with the rust on Bromus, but the year following this rust was shown to have aecia on *Clematis virginiana*.[10]

In 1907 *Puccinia Agropyri* E. & E., as it occurred in Colorado on Agropyron, was found to go to *Clematis ligusticifolia,* a connection that had been demonstrated by Dietel with European hosts fifteen years before. The following year *Puccinia cinerea* Arth. on Puccinellia was grown on *Ranunculus Cymbalaria,* a rust from *Koeleria cristata* on Mahonia, from Bromus on Thalictrum, from Agropyron on Aquilegia, the last three being described as new species. In 1915 aecia on Hydrophyllum from Utah were made to grow on Agropyron and Elymus, giving rise to uredinia and telia similar to those from the Ranunculaceous aecia, but believed to constitute a distinct species. In 1916 another rust on *Koeleria cristata* was grown on Laciniaria under the name *P. Liatridis* (Ell. & And.) Bethel. Repeated attempts were made to find the aecial host of the common leaf rust of wheat, *P. triticina* Erikss., but without success, although there were many indications that pointed to a Ranunculaceous host, and especially to Clematis or Anemone. It was thought that a favorable trial on *Clematis Flammula* would give a measure of success. At any rate it was believed to be one of the numerous races of the subepidermal leaf-rust of grasses, *P. Agropyri,* with Ranunculaceous hosts for its aecia.[11]

The series were discontinued before the study of the subepidermal forms was completed, but ten of them had been connected with their aecia. The conviction had been growing for some time that some of these ten names represented races of *Puccinia Agropyri,* rather than independent species, as was stated in discussing the cultures of 1912. When the manuscript was pre-

[10] For a full account and explanation of the mistake of 1903 in supposedly connecting aecia on Dirca with the Bromus rust see Journal of Mycology 11: 62–63. 1905.

[11] Mycologia 9: 276. 1917.

pared for the North American Flora *P. tomipara, P. Agropyri, P. cinerea, P. alternans* and *P. obliterata,* as well as *P. triticina,* were placed under the one name of *P. Clematidis* (DC.) Lagerh. It is considered a great advance to bring from the limbo of *P. rubigovera,* six distinguishable species, some of them having a considerable number of recognized races, and thereby making it possible to relegate to obscurity some dozen or more names that had previously been encumbering the literature of the rusts.

In a somewhat similar way the American Carex rusts were in utter confusion at the beginning of the cultures. They were quite generally called *Puccinia Caricis* or *P. caricina,* no cultures with American material having been made, and diagnostic characters not having been well worked out. Altogether ten species were grown during the culture period to show their full life cycle, and in several of them a number of races was found, including the one-celled *Uromyces perigynius.* Of course, being able to separate these ten species made it possible to decide upon the identity of other species, which were not actually grown.

A view generally held when the culture work began was that the hosts of an autoecious species, or of each of the two parts of a heteroecious species, would be found to be closely related, often, indeed, to be but a single species, or genus, and certainly always within a single family. Consequently it was felt that when a grass or sedge rust was successfully cultured, the problem about hosts for that species was practically solved. This complacent opinion was quite upset in the case of *Puccinia subnitens* Diet. on *Distichlis spicata,* which in 1902 was first grown upon *Chenopodium album.* In 1904 Rev. J. M. Bates of Nebraska, who had made the field observations and suggestions for this combination, wrote that he had been continuing his observations of this species and believed that it had aecia also on hosts belonging to two other families, which seemed to the writer at the time as most incredible. Tests, however, showed it would flourish on species of Cleome, Lepidium, Sophia and Erysimum, as well as on Chenopodium, compelling the admission that it would grow "with equal vigor upon species belonging to three families of plants," at the time being a "remarkable fact not known for any

other species of rust." Additional genera in the same families were added from time to time for aecial hosts, until in the cultures of 1916 the species was grown on Abronia and Polygonum, thus adding two more families. Mr. E. Bethel, of Denver, Colorado, who made the field observations and suggestions for the later additions, has continued the list since the culture series stopped and brought the number up to 76 species, belonging to 19 families,[12] a truly astonishing showing, and all the more so as no clearly defined races have so far been detected. The only other species of rust with such a remarkably extended series of aecial hosts at all approaching *P. subnitens* Diet., is that of *P. Isiacae* (Thüm.) Wint. from the dry trans-Caspian region of western Asia, as reported by Tranzschel.[13] This species with telia on *Phragmites communis* has aecia on 19 species of hosts belonging to 9 families, the aecial families being the same as for *P. subnitens*.

In still another way the conception of species was modified when in 1905 teliospores from *Ruellia ciliosa* were grown on the same host and also on *R. strepens*. The latter host, with loose, watery tissues, gave rise to aecia fully ten per cent. larger in every way than did the former host with its firm, woody tissues, thus showing that the forms recognized by the Sydows under *Puccinia lateripes* B. & Rav. and *P. Ruelliae* (B. & Br.) Lagerh.[14] represent only a host influence upon one and the same species, this influence being traced not only in the aecia, but also in the other spore-forms.

Thus it will be seen that while the main work of the cultures was effective in completing the life cycles for many species, and in some cases extending and defining the range of hosts, it was at the same time most profoundly modifying the current conception of species among the rusts. Instead of a rigid ideal of a few invariable characters and a limited range of nearly related hosts to be determined by cultures, we have substituted a complex of somewhat variable morphological characters as the basis,

[12] Bethel, Phytopathology 9: 193. 1919.

[13] Beiträge zur Biologie der Uredineen. Trav. Mus. Bot. Acad. Sci. St. Petersb. 3: 40. 1906; 7: 14. 1909.

[14] Sydow, Monographia Uredinearum 1: 235. 1902.

with a more or less extended range of hosts in part determined by cultures and in part by microscopical similarities in the fungus. A species at the beginning of the work was conceived as a simple and direct succession of individuals of the same appearance, capable of being demonstrated by cultures, but at the close had become a bundle of somewhat mobile characters, often comprising many strains varying physiologically and sometimes morphologically, and to a more or less extent not interchangeable by cultures.

In some other ways than already mentioned the accepted notions regarding rusts were modified. It was found that teliospores among the grass forms were not all necessarily resting spores, and that the non-resting forms presented special problems, whose solution was not far advanced when the work came to a close. Assistance with field observations and material permitted successful cultures to be made in May, 1911, with the aeciospores from Arabis sown on Trisetum. The Arabis aecia arise from systemic mycelium extending throughout the stem and leaves of the plant. A month later teliospores resulting from this culture, now having become mature, were found to be capable of germination and were sown on seedling rosettes of Arabis. The results of this sowing first definitely showed when the axis of the Arabis began to elongate as growth started the following spring. A culture was similarly carried out in 1903 with *Puccinia Eatoniae,* using the aecia on *Ranunculus abortivus,* also a form with diffused mycelium, but a reciprocal culture was not made. These two species of rusts, having a systemic form of aecia, were the only ones of the kind which were brought under culture. They belong to an interesting class physiologically, with systemic aecia, and with teliospores capable of germination upon maturity, which possibly do not retain their viability through the winter, or only to an impaired degree.

The culture work began with the too prevalent idea that all rusts could be expected to conform in general to the well known *Puccinia graminis.* It closed with the conviction that the rusts are far too diversified in their morphology, their numerous characters, their physiological adaptations, and their range of hosts,

to be represented by *Puccinia graminis* in more than one out of numerous aspects. In this resumé of cultures only a few of the more prominent developments that should help to modify the too rigid and restricted ideas of rust species as commonly held have been brought forward. Yet enough has been said possibly to indicate the value of what has been accomplished and the need of more extended work along similar lines.

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SOME NEW HAMPSHIRE FUNGI*

L. O. Overholts

The state of New Hampshire, and in fact most of New England, has been an important collecting ground for considerably more than a half century. Notwithstanding this fact the botanical literature of the region contains only a meager amount of information dealing with its cryptogamic flora. For the state of New Hampshire the writer is aware of but a single paper treating to any extent the fungous flora of the state. This was an eighteen page article by the late Dr. W. G. Farlow, appearing in volume 3 of Appalachia, published in 1884. Here are listed a total of 107 species distributed through 63 genera, representing collections made in the vicinity of Shelburne, Mt. Washington, etc., in 1882 and 1883. Of this list, there are 13 species of Myxomycetes, 2 of Phycomycetes, 33 of Ascomycetes, 16 of Fungi Imperfecti, 6 of Smuts, 20 of Rusts, and 17 of Hymenomycetes.

Aside from this paper the literature contains only incidental reference to fungi collected in or described from the state, although abundant material probably exists in a number of different herbaria. Dr. Farlow, himself, had a summer home at Chocorua, and undoubtedly collected a wealth of material in that locality. Many other botanists have also visited the White Mountain region, and if all this material could be brought together a fairly complete list of the fungi could probably be made up.

In 1918 the writer spent about twenty weeks, from April to September, in New Hampshire, as an employee of the Bureau of Plant Industry, Washington, D. C. During this time headquarters were established at North Conway on the edge of the White Mountains, and not many miles distant from Dr. Farlow's home at Chocorua. This location gave access to an excellent

* Contribution from the Department of Botany, The Pennsylvania State College, No. 26.

forest region of pine, balsam, spruce, and hemlock, as well as to hardwood areas of beech, maple, birch, alder, etc. North Conway and Intervale were the chief local collecting centers. A number of trips were made to Crawford Notch in the heart of the White Mountains, and there the forests are mainly hardwoods with scattering balsam and spruce. An extensive "wind throw" of several years age is located in this region and proved to be a rich collecting ground. One trip was made to Lisbon, another to Bethlehem, and a three day excursion to the summit of Mt. Washington by way of Tuckerman Ravine and returning to Crawford Notch. Advantage was taken of every opportunity for picking up at all times any fungi observed. But only in special groups was the attempt made to collect the same species from different localities or different substrata. In fact, because of other duties, no systematic collecting was done except what might be indulged in at odd times, on holidays, Sundays, etc. Consequently, the species here listed are for the most part the ones that the ordinary collector would casually notice because of their size, coloration, or other conspicuous characteristic. Nevertheless, the number of collections made was sufficient to furnish the appended list of 195 species of fungi, every one of which is represented in the writer's herbarium by one or more collections. These species are here listed under about 77 different genera. It is a curious fact, that in this list scarcely more than a dozen species duplicate collections reported by Dr. Farlow. This is mostly explained by the fact that the species he reported belong largely to the lower groups of fungi, while the writer has collected more among the higher Basidiomycetes. A number of duplicates from these collections have been furnished the Herbarium of the United States Department of Agriculture, the Missouri Botanical Garden, the Herbarium of Dr. J. S. Weir, of Dr. H. H. York, then located at Brown University, Providence, R. I., and of the Department of Botany of the Pennsylvania State College. For this reason the writer's herbarium numbers are always cited in the list, that they may the more definitely identify duplicate collections in other herbaria.

Unless otherwise noted, the collections were made by the

writer, or in company with Dr. H. H. York, to whom the writer is much indebted for assistance. Various other individuals also contributed collections and such are credited in the list. Special thanks are due to those mycologists mentioned for determinations of various collections, as they have thereby added to the completeness and accuracy of the list.

In closing this introduction I cannot fail to mention one of the unsolved problems encountered in the spruce forests of this region. Many individuals of the red spruce (*Picea rubens*) are here attacked by a heart-wood decaying organism producing a "carbonizing" type of decay somewhat similar to that produced in structural timbers by *Trametes carnea*. The attacked heart-wood becomes reddish-brown and shrinks and cracks both longitudinally and transversely. In the final stages of decay the wood crumbles to a fine dry powder when rubbed between the thumb and finger. The fate of such trees is sooner or later to become windthrown, breaking off usually within six feet of the ground, indicating that the fungus is especially active in this region of the trunk. Although this disease was recognized early in the season and a constant lookout kept for sporophores, none were found that would in any way indicate the species responsible for the damage caused. The trees are from 5 to 15 inches in diameter, breast high, at the time they are wind thrown. That the causal organism is a member of the Polyporaceae there is little room for doubt, but its generic and specific identity remain to be determined.

FUNGI IMPERFECTI

1. Order Sphaeropsidales

1. *Leptothyrium perichymeni* (Desm.) Sacc. On leaves of Lonicera sp. North Conway, No. 5266. Determined by Mrs. F. W. Patterson.
2. *Septoria acerina* Peck. On leaves of *Acer pennsylvanica*. North Conway and Willey Station. Nos. 5695 and 5696, respectively. Determined by Dr. J. J. Davis.
3. *Septoria rubi* West. On leaves of *Rubus villosus*. North Conway. No. 5697.
4. *Septoria saccharina* E. & Ev. On leaves of *Acer saccharum*. Crawford Notch. No. 5690. Determined by Dr. J. J. Davis.

ASCOMYCETES

1. ORDER PERISPORIALES

5. *Microsphaera grossulariae* (Wal.) Lév. On leaves of *Ribes prostratum*. White Horse Ledge (North Conway), No. 5220; Jackson, No. 5221.

2. ORDER HYPOCREALES

6. *Cordyceps militaris* (L.) Link. On larva. Crawford Notch, No. 4983. Distribution recorded by Seaver[1] as "Massachusetts to North Dakota and Virginia."

[1] North American Flora 3: 49. 1910.

7. *Hypomyces hyalinus* (Schw.) Tul. On *Amanita rubescens*. Willey Station, No. 4969; North Conway, No. 5139.
8. *Hypomyces lactifluorum* (Schw.) Tul. On *Lactarius*. North Conway, No. 4754; Intervale, No. 5142.
9. *Nectria cinnabarina* (Tode) Fr. On dead *Acer saccharum*. North Conway, No. 4612; on dead stems of *Ribes prostratum*, No. 4862.
10. *Nectria cucurbitula* Sacc. On bark of fallen *Abies balsamea*. Crawford Notch, No. 4946. Determined by Dr. F. J. Seaver.
11. *Scoleconectria scolecospora* (Bref.) Seaver. On dead branches of *Pinus strobus*. Lisbon, No. 4700. Distribution recorded by Seaver[2] as "New Jersey to Maryland and California." This is the fungus most often associated with the white pine blister-rust in that region.

[2] Loc. cit.

3. ORDER SPHAERIALES

12. *Hypoxylon coccineum* Bull. On bark of *Fagus*. Crawford Notch, No. 4552. Collected by H. H. York and L. E. Newman.
13. *Hypoxylon cohaerens* (Pers.) Fr. On dead *Fagus*. North Conway, No. 5066.

4. ORDER PHACIDIALES

14. *Coccophacidium pini* (A. & S.) Karst. On dead limbs of *Pinus strobus*. North Conway, No. 5044.

5. ORDER PEZIZALES

15. *Dasyscypha agassizi* (B. & C.) Sacc. On fallen *Abies balsamea*. Crawford Notch, No. 4841; base of Mt. Washington, No. 4861. Determined by Dr. F. J. Seaver. Not an uncommon plant and usually making a profuse growth on the dead bark.
16. *Dermatea prunastri* (Pers.) Fr. On dead *Prunus* sp. North Conway, No. 5064. Collected by A. S. Rhoads.
17. *Humaria aggregata* (B. & Br.) Cooke. On the ground among pine needles. North Conway, No. 5063. Determined by Dr. F. J. Seaver who writes in part as follows: "I have seen only one other specimen of this species and that a very small one from Indiana."
18. *Tympanis pinastri* Tul. On fallen trunk of *Abies balsamea*. Crawford Notch Bridle Path to Mt. Washington, No. 5037. The determination was made by Dr. Seaver.

6. Order Helvellales

19. *Helvella infula* Schaeff. On the ground in moist coniferous woods. North Conway, No. 4932. Determined by Dr. Seaver. The specimens have much the appearance of a small *Gyromitra.*
20. *Leotia lubrica* (Scop.) Pers. In moist humus. North Conway, No. 5080. Rather common.
21. *Microglossum rufum* (Schw.) Underw. On rotten mossy logs. North Conway, No. 5120.
22. *Spathularia velutipes* Cooke & Farlow. On the ground in woods. Willey Station, No. 5083.
23. *Vibrissea truncorum* A. & S. On submerged wood in cold mountain stream. Tuckerman Ravine, No. 4979.

BASIDIOMYCETES

Hemi-Basidiomycetes

1. Order Ustilaginales

24. *Urocystis agrogyri* (Preuss.) Schröt. On an undetermined grass. Kearsarge, No. 4870.

2. Order Uredinales

25. *Coleosporium solidaginis* (Schw.) Thüm. Aecia on needles of *Pinus resinosa.* North Conway, Nos. 4901, 4927. First observed June 12, and last collected Aug. 1. Uredinia and telia on species of *Aster, Solidago* and *Euthamia,* North Conway and Crawford Notch, Nos. 5694 and 5693, respectively.
26. *Cronartium comptoniae* Arth. On *Comptonia asplenifolia.* North Conway, No. 4616; on *Pinus rigida,* North Conway, No. 5126.
27. *Cronartium ribicola* Fischer. Collections are preserved as follows: On *Ribes aureum,* North Conway and Bath, Nos. 4911 and 4596 respectively, the latter collection by H. H. York; on *R. cynosbati,* Lisbon, Bartlett and Jackson, Nos. 4587, 5222 and 4617 respectively; on *R. lacustre,* Crawford Notch, Nos. 4588 and 4594; on *R. nigrum,* Bethlehem and North Conway, Nos. 4619 and 4598 respectively; on *R. oxyacanthoides,* Crawford Notch, No. 4590; on *R. prostratum,* North Conway and slope of Moat Mt. at about 2600 ft. elevation, Nos. 4602 and 4640 respectively, the latter collection by P. R. Gast; on *R. triste,* Crawford Notch, Nos. 4589 and 4600; on *R. vulgare,* North Conway, No. 4601; also observed, but no collections preserved, on *R, grossularia,* at North Conway. The aecial stage on white pine is widely distributed through this part of the state. Numerous collections were made in the region of North Conway, South Conway, Intervale, and Lisbon.
28. *Gymnosporangium clavariaeforme* (Jacq.) DC. On *Juniperus communis* var. *depressa.* North Conway, No. 5001.
29. *Gymnosporangium cornutum* (Pers.) Arth. On leaves of *Sorbus (americana?).* Intervale, No. 5689. Determined by F. D. Kern.
30. *Kuhneola uredinis* (Link) Arth. On leaves of *Rubus villosus.* Tuckerman Ravine, No. 4889.

31. *Melampsora medusae* Thüm. On leaves of *Populus tremuloides*. North Conway, No. 4657. Collected by A. S. Rhoads.
32. *Melampsorella elatina* (A. & S.) Arth. On *Abies balsamea*, forming witches brooms. North Conway, No. 4890.
33. *Melampsoridium betulae* (Schum.) Arth. On *Betula populifolia*. North Conway, No. 4670. Collected by A. S. Rhoads.
34. *Puccinia clematidis* (DC.) Lagerh. Aecia on leaves of *Clematis* sp. Crawford Notch, No. 4909.
35. *Puccinia fraseri* Arth. On leaves of *Hieracium* sp. North Conway, No. 5692. Determined by Prof. C. R. Orton.
36. *Puccinia graminis* Pers. Pycnia and aecia on leaves of *Berberis vulgaris*. Intervale, No. 4649.
37. *Puccinia grossulariae* (Schum.) Lagerh. Aecia on *Ribes prostratum* and *R. cynosbati*; at Crawford Notch and Jackson respectively; Nos. 4585 and 4614 respectively.
38. *Puccinia obscura* Schroet. On leaves of *Luzula*. Jackson, No. 5687. Collected by H. H. York. Determined by C. R. Orton.
39. *Puccinia pedatata* (Schw.) Arth. Aecia on leaves of *Viola saggitata*?. North Conway, No. 4908.
40. *Puccinia physostegiae* (Peck) Kuntze. Aecia on leaves of *Physostegia virginiana*. North Conway, No. 4913.
41. *Puccinia taraxaci* Plowr. On leaves of *Taraxacum officinale*. No. 5688. Collected by H. H. York.
42. *Uredinopsis mirabilis* (Peck) Magnus. On leaves of *Abies balsamea*. Franconia, No. 4980; on leaves of *Dryopteris, Franconia*, No. 5288.
43. *Uromyces caladii* (Schw.) Farlow. Aecia on *Arisaema triphyllum*. North Conway, No. 4910.
44. *Uromyces houstoniata* (Schroet.) Sheldon. Aecia on *Houstonia coerulea*. North Conway, No. 4616.

EU-BASIDIOMYCETES

1. Family Tremellaceae

45. *Exidia glandulosa* (Bull.) Fr. On dead *Fagus*. North Conway, No. 5116.
46. *Sebacina calcea* (Pers.) Bres. On fallen *Pinus rigida*. Intervale, No. 5108. The fungus was determined by Dr. E. A. Burt.
47. *Tremellodon gelatinosum* (Scop.) Fr. On rotten hemlock stump. North Conway (Hales Location), No. 5158.

2. Family Dacryomycetaceae

48. *Calocera cornea* Fr. On log of *Acer*. Crawford Notch, No. 4746.
49. *Dacryomyces hyalinus* Quel. On hemlock(?) log. Intervale, No. 5147. Determined by Mr. C. G. Lloyd.

3. Family Thelephoraceae

50. *Aleurodiscus acerinus* (Pers.) v. Hohn. & Litsch. On bark of living *Fraxinus americanus*. North Conway, No. 5104.

51. *Aleurodiscus amorphus* (Pers.) Rab. On dead limbs of *Abies balsamea.* Crawford Notch Bridle Path to Mt. Washington, No. 4840.
52. *Corticium albulum* Atk. & Burt. On dead *Prunus.* North Conway, No. 5111.
53. *Corticium galactinum* (Fr.) Burt. All collections at North Conway. On coniferous logs, No. 4555; on hemlock log, No. 5131; on log of *Acer,* No. 4584; on log of *Betula populifolia,* No. 4945. No. 4555 and 4584 were determined by Dr. E. A. Burt.
54. *Corticium laetum* Karst. On dead *Alnus.* Crawford Notch (Mt. Webster), No. 5079.
55. *Corticium subgiganteum* Berk. On dead *Acer* branches. North Conway (Hales Location), No. 5062. Determined by Dr. E. A. Burt.
56. *Cyphella fasciculata* (Schw.) B. & C. On dead *Alnus.* North Conway, No. 5052.
57. *Hymenochaete abnormis* Peck. On the exposoed heart-wood on the end of a log of *Picea rubens.* Crawford Notch, No. 4948. The determination was made by Dr. E. A. Burt, who, however, prefers to class the fungus in the genus *Stereum* rather than in *Hymenochaete.* It has considerable resemblance to *H. rubiginosum* (Dicks.) Lév. Spores cylindric when mature, hyaline, 7–12 × 3–4 μ, sometimes somewhat shorter when on basidia.
58. *Hymenochaete corrugata* (Fr.) Lév. On dead wood, probably of *Acer.* North Conway, No. 5053.
59. *Hymenochaete tabacina* (Sow.) Lév. All collections in the vicinity of North Conway. On wood of *Acer,* Nos. 4734 and 4551; on wood of *Acer rubrum,* No. 5036; on fallen hemlock, No. 5112. A coniferous host for this species is not often found.
60. *Peniophora affinis* Burt. On dead *Alnus incana.* North Conway, No. 5106.
61. *Peniophora allescheri* Bres. On dead *Populus.* North Conway, No. 4564.
62. *Peniophora carnosa* Burt. On rotten *Acer* log. North Conway, No. 4732; on fallen *Pinus rigida,* Intervale, No. 5039.
63. *Peniophora cinerea* (Fr.) Cooke. On dead *Ulmus americana.* No. 4858.
64. *Stereum ambiguum* Peck. On coniferous fence timber. North Conway, No. 4553.
65. *Stereum hirsutum* Fr. On dead *Alnus.* North Conway, No. 5009.
66. *Stereum lilacino-fuscum* (B. & C.) Burt. On dead *Acer* twigs. Nos. 5032, 5161.
67. *Stereum rameale* Schw. On fallen *Acer rubrum.* North Conway, No. 4956; on *Fagus americana,* No. 5020.
68. *Stereum rufum* Pers. On dead *Populus* twigs. North Conway, No. 4931.
69. *Stereum sanguinolentum* A. & S. On fallen *Abies balsamea.* Tuckerman Ravine, No. 4949; on *Tsuga canadensis,* North Conway, No. 4963.
70. *Stereum sulcatum* Burt. On log of *Tsuga canadensis.* North Conway, No. 5033. Determined by Dr. E. A. Burt.
71. *Stereum tuberculosum* Fr. On fallen *Acer saccharum.* Crawford Notch, No. 4582; on coniferous log, North Conway, No. 5074; on dead *Betula,* North Conway, No. 5110.

72. *Thelephora palmata* Fr. On the ground in woods. North Conway, No. 4978. With a decidedly foetid odor in fresh plants.
73. *Thelephora terrestris* (Ehrh.) Fr. On the ground and growing over mosses, twigs, etc. North Conway, No. 4873; on rotten stump of *Pinus resinosa,* No. 4958. Both collections were made by Dr. H. H. York.
74. *Tulasnella fusco-violacea* Bres. On bark of *Abies balsamea.* Crawford Notch, No. 4883. Determined by Dr. E. A. Burt. There occurs rather abundantly in this region a peculiar fungus growing exclusively on the bark of living trees of *Pinus strobus,* in which it forms orbicular patches 1 to 2.5 cm. broad. It is entirely resupinate, or at least practically so, and of a light brown color. The surface is rough with a matter, strigose pubescence. No hymenium can be found. In general appearance the fungus has the appearance that one would expect of a resupinate species of *Stereum.* However, Dr. Burt suggests that it may be a species of *Septobasidium.* Mycologists who have opportunity to collect in this region through a longer period of time than have I can render a distinct service by observing and collecting this peculiar fungus in the endeavor to obtain it in fruiting conditions. It can be found on the uninjured bark of trees 20 to 50 years old, and only where they grow in dense stands.

4. Family Clavariaceae

75. *Clavaria fusiformis* Sow. Among moss in forest trail. North Conway, No. 5060. Collected by Dr. H. H. York.
76. *Clavaria krombholtzii* Fr. On the ground in woods. North Conway, No. 5172.

5. Family Hydnaceae

77. *Asterodon setigera* Peck. On rotten hemlock log. North Conway, No. 5059.
78. *Hydnum coralloides* (Scop.) Fr. On end of oak log. North Conway, No. 5148.
79. *Hydnum ochraceum* Pers. On log of *Acer.* North Conway, No. 4736.
80. *Phlebia strigoso-zonata* Schw. On dead *Populus.* North Conway, No. 5133.
81. *Radulum casearium* Morgan. On log of *Populus.* North Conway, Nos. 4637, 5132.

6. Family Agaricaceae

82. *Amanita flavoconia* Atk. In rich humus in woods. North Conway, Nos. 4569, 4729 and 4738.
83. *Amanita morrisii* Peck. On the ground in damp woods. North Conway, No. 4737.
84. *Amanita muscaria* (L.) Fr. On the ground under aspens. Willey Station, No. 4663.
85. *Amanita rubescens* Fr. On the ground in moist woods. North Conway, No. 4735.

86. *Armillaria mellea* Vahl. On roots of a dead *Prunus serotinus*. North Conway, No. 5095.
87. *Cantharellus cibarius* Fr. On the ground in woods. North Conway, No. 4748.
88. *Cantharellus floccosus* Schw. On the ground in woods. North Conway, Nos. 5065 and 5135.
89. *Cantharellus umbonatus* Fr. Among Polytrichum moss under pines. North Conway, Nos. 4749 and 4977.
90. *Clitocybe clavipes* Pers. On the ground under pines. North Conway, No. 4930.
91. *Clitocybe infundibuliformis* Bull. Among Polytrichum moss under alders. No. 4658.
92. *Clitocybe virens* (Scop.) Fr. On the ground under aspens. Willey Station, No. 4751.
93. *Collybia acervata* Fr. On rotten wood. Crawford Notch (Mt. Webster), No. 4965.
94. *Collybia dryophila* (Bull.) Fr. On the ground under pines. North Conway, No. 4866.
95. *Collybia platyphylla* Fr. Around an old stump. North Conway, No. 4756.
96. *Hypholoma incertum* Peck. On a lawn. North Conway, No. 4856. Collected by Dr. H. H. York.
97. *Lactarius deceptivus* Peck. On the ground in woods. North Conway, Nos. 4825 and 4851. The latter collection by Dr. A. S. Rhoads.
98. *Lactarius hygrophoroides* Peck. On the ground in woods. North Conway, No. 4757.
99. *Lentinus lepideus* Fr. On railway ties, North Conway, No. 4554; on pine stump, North Conway, No. 5105. A very common species.
100. *Lentinus ursinus* Fr. On rotten log. North Conway, No. 4871.
101. *Lepiota granulosa* (Batsch) Fr. On the ground under aspens. Willey Station, No. 4758.
102. *Lepiota procera* (Scop.) Fr. On the ground in woods. North Conway, No. 4872.
103. *Marasmius androsaceus* (L.) Fr. On needles, twigs, etc., on the ground. North Conway, No. 5134.
104. *Marasmius archyropus* Fr. On the ground in woods. Crawford Notch, No. 5090.
105. *Marasmius multifolius* Peck. On the ground under aspens. Willey Station, No. 5087.
106. *Marasmius oreades* (L.) Fr. By grassy roadside. North Conway, No. 5081.
107. *Marasmius rotula* (Scop.) Fr. On beech log. Crawford Notch, No. 5141.
108. *Marasmius subnudus* (Ellis) Peck. On the ground and on wood. North Conway, No. 5159.
109. *Mycena leaiana* Berk. On log of *Fagus*. North Conway, No. 4563.
110. *Panaeolus solidipes* Peck. On manure heap. North Conway, No. 4761.
111. *Panus rudis* Fr. On log of *Fagus*. North Conway, No. 5127.
112. *Paxillus atrotomentosus* (Batsch) Fr. On the ground by a pine stump. North Conway, Nos. 4750 and 4753.

113. *Paxillus involutus* Fr. On the ground in woods. North Conway, No. 4752.
114. *Pholiota marginella* Peck. On rotten mossy log. North Conway, No. 4762.
115. *Pholiota mycenoides* Fr. In wet, marshy ground among scattered *Sphagnum*. North Conway, No. 4943.
116. *Pleurotus ostreatus* (Jacq.) Fr. On fallen beech, Crawford Notch, No. 4855; on dead wood, Intervale, No. 5000.
117. *Pluteus cervinus* (Schaeff.) Fr. In old roadway. North Conway, No. 5153.
118. *Pluteus leoninus* (Schaeff.) Fr. On a rotten log. North Conway, No. 4929.
119. *Russula flavida* Frost. On the ground in woods. Intervale, No. 4667.
120. *Russula mariae* Peck. On the ground in a woods road. No. 5150.
121. *Tricholoma laterarium* Fr. On leaf mold in forest. North Conway, No. 5050.
122. *Trogia crispa* Fr. On dead *Betula populifolia*. North Conway, No. 4982; collected by Dr. A. S. Rhoads; on dead beech limbs, Willey Station, No. 5051.

7. Family Boletaceae

123. *Boletinus pictus* Peck. On the ground in woods. North Conway, No. 5136.
124. *Boletus communis* (Bull.) Fr. On the ground in woods. North Conway, No. 4972.
125. *Boletus cyanescens* (Bull.) Fr. On the ground by roadside. Crawford Notch, No. 4744.
126. *Boletus edulis* (Bull.) Fr. On the ground in woods. North Conway, No. 4960.
127. *Boletus felleus* (Bull.) Fr. On the ground in woods. North Conway, No. 4755.
128. *Boletus ferruginatus* (Batsch) Fr. On the ground in woods. North Conway, No. 4826.
129. *Boletus fumosipes* Peck. On the ground in woods. Willey Station, No. 5160.
130. *Boletus granulatus* (Bull.) Fr. On the ground under trees. North Conway, No. 5107.
131. *Boletus scaber* (Bull.) Fr. On the ground in woods. Intervale, No. 4976.
132. *Boletus subaureus* Peck. On the ground in woods, especially in trails and grassy places. North Conway, No. 4985. Common.
133. *Boletus subglabripes* Peck. On the ground in woods. North Conway, No. 4937.
134. *Boletus subtomentosus* (L.) Fr. On the ground under pines. North Conway, No. 5156.

8. Family Polyporaceae

135. *Daedalea unicolor* (Bull.) Fr. On dead *Acer* and also on *Fagus*. North Conway, Nos. 4842 and 4859.

136. *Favolus canadensis* Klotzsch. On beech limbs. North Conway, No. 4876.
137. *Fomes applanatus* (Pers.) Wallr. On *Acer* stump. North Conway, No. 4694.
138. *Fomes connatus* (Weinm.) Gill. On *Acer saccharinum.* North Conway, No. 4743; on *Acer rubrum,* No. 4986.
139. *Fomes conchatus* (Pers.) Fr. On dead *Acer rubrum.* North Conway, No. 4733; on dead *Acer rubrum,* Intervale, No. 4849; on living *Fraxinus americana,* North Conway, No. 4968.
140. *Fomes fomentarius* (L.) Gill. On *Betula lutea.* North Conway, No. 4724; Intervale, No. 4725.
141. *Fomes igniarius* Fr. On fallen *Populus.* North Conway, No. 4562; on fallen *Populus deltoides,* Crawford Notch, No. 4648; on *Betula lutea,* Jackson and Crawford Notch, Nos. 4727 and 4940; on *Betula populifolia,* Crawford Notch, No. 4951; on *Betula lutea,* Tuckerman Ravine, No. 4966; on dead *Betula alba,* Willey Station, No. 5085.
142. *Fomes pini* (Brot.) Lloyd. On hemlock log. North Conway, No. 4846.
143. *Fomes pinicola* (Sw.) Cooke. On *Betula lutea.* North Conway, No. 4695; on *Abies balsamea,* North Conway, No. 4704, collected by Dr. H. H. York; on dead *Prunus,* Crawford Notch, No. 4947.
144. *Fomes roseus* (A. & S.) Cooke. On dead *Tsuga canadensis.* North Conway, No. 5004.
145. *Fomes scutellatus* Schw. On dead *Alnus.* North Conway, No. 5089.
146. *Lenzites saepiaria* Fr. On rotten coniferous log. North Conway, No. 4742.
147. *Polyporus abietinus* Fr. On *Tsuga canadensis.* North Conway, No. 5008; on fallen *Abies balsamea,* Crawford Notch, No. 5121.
148. *Polyporus adustus* (Willd.) Fr. On dead *Populus.* North Conway, No. 4739; on fallen beech log, Crawford Notch, No. 4868.
149. *Polyporus anceps* Peck. The following collections at North Conway: On dead limbs of *Pinus resinosa,* No. 4865; on trunk of dead *Pinus resinosa,* No. 4988; on dead standing hemlock, No. 5026.
150. *Polyporus betulinus* (Bull.) Fr. On *Betula alba.* Crawford Notch, No. 4839.
151. *Polyporus biformis* Klotzsch. On beech log. North Conway, No. 4957.
152. *Polyporus brumalis* (Pers.) Fr. On dead deciduous wood. North Conway, No. 5084.
153. *Polyporus chioneus* Fr. The following collections at North Conway: On dead *Populus,* No. 4926; on dead *Prunus serotinus,* No. 4941; on log of *Betula,* No. 5006.
154. *Polyporus cinnabarinus* (Jacq.) Fr. On log of *Acer.* Crawford Notch, No. 4568; on fallen *Acer saccharum,* North Conway, No. 5145, collected by Dr. H. H. York and Mr. L. E. Newman.
155. *Polyporus conchifer* (Schw.) Fr. On dead elm branches. North Conway, No. 4745.
156. *Polyporus dichrous* Fr. On dead *Alnus.* North Conway (Hales Location), No. 4987.
157. *Polyporus elegans* (Bull.) Fr. On dead wood. Crawford Notch, No. 5005.

158. *Polyporus epileucus* Fr. ex Lloyd. On fallen *Acer*. Crawford Notch, No. 5002.

159. *Polyporus guttulatus* Peck. On fallen *Abies balsamea*. On Crawford Notch trail to Mt. Webster, No. 5152.

160. *Polyporus hirsutus* (Wulf.) Fr. On fallen beech. Crawford Notch, No. 4864; also on fallen *Populus*, No. 4898.

161. *Polyporus montagnei* Fr. On the ground, probably attached to buried wood. North Conway, No. 4999.

162. *Polyporus pargamenus* Fr. On *Acer rubrum*. Intervale, No. 4650; on fallen *Populus*, Kearsarge Mt. and Crawford Notch, Nos. 4707 and 4884, respectively; on dead *Salix*, North Conway, No. 4884, collected by Dr. A. S. Rhoads.

163. *Polyporus perennis* (L.) Fr. On ground under aspens and in forest trails. Willey Station, No. 5055. Of this species larger specimens were collected than had ever before been observed by the writer, some being as much as 11 cm. broad. It is the common, brown, centrally stipitate species of forest trails and roadsides in this region.

164. *Polyporus picipes* Fr. On rotten *Abies balsamea*. Crawford Notch, No. 4934; on log of *Acer*, No. 4952. A coniferous host for this species is extremely uncommon.

165. *Polyporus pubescens* (Schum.) Fr. On dead *Acer saccharum*. Crawford Notch, No. 5113. Observed but once.

166. *Polyporus radiatus* (Sow.) Fr. On stump of *Betula lutea*. North Conway, No. 5078; on dead *Alnus*, No. 5122.

167. *Polyporus schweinitzii* Fr. On roots of pine stumps. North Conway, Nos. 4740 and 5155.

168. *Polyporus semipileatus* Peck. On dead beech limbs. North Conway, No. 4852.

169. *Polyporus semisupinus* B. & C. On dead *Alnus*. North Conway (Hales Location), No. 5093. Found but once.

170. *Polyporus sulphureus* (Bull.) Fr. On old hardwood log. North Conway, No. 4722. Collected by Dr. H. H. York.

171. *Polyporus tsugae* Murrill. On dead hemlock. Intervale, No. 4613, by Mr. J. Corliss; North Conway, No. 4620.

172. *Polyporus tulipiferus* (Schw.) Overh. On dead *Acer pennsylvanica*. Crawford Notch, No. 4583; on dead *Prunus serotinus* and also on dead beech limbs, North Conway, Nos. 4967 and 5130 respectively.

173. *Polyporus ursinus* Lloyd. On log of *Picea rubens*. North Conway, No. 6076. This species was collected in August, 1920, by Mr. Walter H. Snell. It is a rare plant though rather widely distributed in the United States.

174. *Poria attenuata* Peck. On dead hardwood. North Conway, No. 4566; on dead *Acer* limbs, No. 5171.

175. *Poria attenuata* var. *subincarnata* Peck. On dead limbs of *Tsuga canadensis*. North Conway, Nos. 5034 and 5099. This plant is not a variety of *P. attenuata* as has already been pointed out by the writer (Bull. N. Y. State Mus. 205–206; 73–74. 1919.) It is a distinct species but whether or not otherwise named I cannot say at present.

176. *Poria betulina* Murrill. On fallen *Betula populifolia.* Crawford Notch, Nos. 4565 and 5013; on *Betula alba,* No. 5025. This species has been extensively studied by the writer and will be considered more in detail in a paper soon to be published. It is common throughout the northeastern states, but without knowing the host it is difficult to distinguish from resupinate forms of *Fomes igniarius.* The spores were originally described as "ovoid, smooth, fulvous, 4–5 μ long." They are, however, subglobose, smooth, *hyaline,* and measure 5–6 μ in diameter. The species is consequently misplaced in Murrill's genus *Fomitiporella,* in which the brown spores are made a generic character.

177. *Poria ferruginosa* (Schrad.) Fr. On dead limbs of *Acer.* North Conway, No. 4672; on fallen *Prunus serotinus,* Crawford Notch, No. 4971; on dead *Fagus,* Willey Station, No. 5096. Among other brown resupinate species this one is well characterized by the abundant setae, the distinctly oblong or oblong-ellipsoid hyaline spores measuring 4–5 × 2–2.5 μ, and by being confined to the wood of deciduous trees.

178. *Poria fimbriata* Pers. On rotten wood. North Conway, No. 4607. The species is sometimes known as *Porothelium fimbriatum.*

179. *Poria medulla-panis* Pers. On old limbs of deciduous trees. North Conway, No. 5035.

180. *Poria nigrescens* Bres. On rotten *Betula.* North Conway, No. 4942.

181. *Poria prunicola* Murrill. On dead *Prunus.* Crawford Notch, No. 4580. This is a rather common *Poria* on dead *Prunus,* especially at the higher elevations in the vicinity of Crawford Notch. Its affinities are with *Poria betulina.* Setae are rare, but usually present.

182. *Poria subacida* Peck. On fallen *Acer rubrum.* Intervale, No. 4641; on fallen hemlock, North Conway, Nos. 4827 and 5046; on fallen *Abies balsamea,* Intervale, No. 4974; on dead *Betula,* North Conway, No. 5049; on log of *Pinus Strobus,* North Conway, No. 5097. A common and variable species.

183. *Poria tsugina* Murrill. On log of *Tsuga canadensis.* North Conway and Lisbon, Nos. 4962 and 5091 respectively.

184. *Trametes carnea* Nees. On log of *Picea mariana* and on pine log. North Conway, Nos. 4731 and 4933 respectively.

185. *Trametes heteromorpha* Fr. On fallen *Abies balsamea.* Crawford Notch, No. 5045. This species has only recently been recognized in this country (see Overholts, Polyporaceae of the Middle-Western United States, p. 74. 1915). Its occurrence in such widely separated localities as Idaho and New Hampshire argues for a wide distribution.

186. *Trametes malicola* B. & C.? On rotten log of hemlock or red spruce. North Conway, No. 5100. The specimens may belong rather under *Fomes annosus.* More recent studies indicate that the real affinities of this species are with *Fomes annosus* under which it is now included as a weathered form.

187. *Trametes mollis* Sommerf. On fallen *Acer.* Crawford Notch, No. 4608, collected by Dr. H. H. York and Mr. L. E. Newman; on fallen *Fagus* and *Acer,* Crawford Notch, No. 5129.

188. *Trametes peckii* Kalchbr. On log of *Populus grandidentata* Dundee, No. 5047.

189. *Trametes sepium* B. & C. On oak fence posts. North Conway, No. 5123.

190. *Trametes serialis* Fr. On coniferous wood. North Conway, No. 4854; on fallen *Abies balsamea,* Crawford Notch, No. 4925; on hemlock log, Lisbon, No. 5073.

191. *Trametes variiformis* Peck. On hemlock logs. North Conway, Nos. 4571 and 4605; on fallen *Picea rubens,* North Conway, No. 5076.

ADDENDA

192. *Puccinia gnaphaliata* (Schw.) Arth. & Bisby. Aecia on *Gnaphalium* sp. North Conway, No. 5225. Collected by H. H. York. Determined by C. R. Orton, who includes the species in the genus *Allodus* as recently monographed by him. *P. investita* Schw. is given as a synonym.

193. *Pucciniastrum potentillae* Kom. Uredinia on leaves of *Potentilla tridentata.* Tuckerman Ravine, Mt. Washington, No. 5226. Determined by C. R. Orton. This species is not included in the treatment of the genus *Pucciniastrum* as given in the North American Flora. Dr. J. J. Davis records it from Wisconsin on the same host.

194. *Septoria humuli* Westend. On leaves of *Humulus.* Intervale, No. 5219. The spore measurements, 20–30 × 1 μ, agree better with this species than with *S. lupulina* Ellis & Kell.

195. *Septoria ribis* Desm. On leaves of seedling *Ribes prostratum.* North Conway, No. 5227. Spores ilnear, elongate, curved or straight, 40–60 × 1 μ. No septations are visible in the spores but the fruiting body is surely a pycnidium rather than an acervulus.

STATE COLLEGE,
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THE FUNGI OF THE WILKES EXPEDITION

William W. Diehl

The U. S. Exploring Expedition under the command of Charles Wilkes, 1838–42, in connection with other work of a scientific character made collections of plants which have been a notable contribution to a floristic knowledge of the lands explored. The fungi collected on this expedition (1) were, however, singularly few, thirty-one in all, eight of which were described as new (2).

In spite of the character of this limited collection and the status of Berkeley and Curtis as eminent mycologists of the period, the eight new species do not seem to have been generally recognized in the literature. Massee (3) in his monograph does not mention Nos. 21 and 23. Cooke (4) in his "Australian Fungi" makes no mention of these Berkeley and Curtis species. Hennings (5) in a compendium of South Sea fungi calls attention to but one of the list, No. 21, as *Thelephora lamellata* B. Guppy (6) listing the fungi of the Solomon Islands similarly cites this species only. Berkeley (7) himself cites only this one of the Wilkes Expedition names in his "Fungi of the Challenger Expedition." None of them occurs in Berkeley's (8) part of the Flora of New Zealand. It is indeed strange that Berkeley and others, except by citation of the Wilkes literature, do not seem to refer in subsequent publications to any other collections of these species either directly or in synonymy.

This lack of reference to these fungi is doubtless due to the fact that the types have been lost to mycologists in that they have probably not been recognized since their original description. The species were published (2) as new less than six months after Curtis studied them, if his study was coincident with his reference in a letter to Professor Edw. Tuckerman dated Dec. 9, 1850.[1] He notes finding some lichens among the fungi of the

[1] Dr. C. L. Shear has kindly permitted the writer to examine a photostat copy of the letters written to Tuckerman from 1847 to 1850.

U. S. Exploring Expedition; he says further: "The fungi are few—30 species only—8 new." Collins (9) describes the unfortunate disposition of various specimens and publications of the Wilkes Expedition. The fungi apparently met a similar experience since less than half can be located. In the early days of the U. S. Department of Agriculture, as revealed by the old handwriting on index cards and by the character of the specimen envelopes, some of these were inserted in what is now the Pathological Collections of the Bureau of Plant Industry, where they have been kept intact though unrecognized as belonging to the Wilkes Collection. A search through the governmental herbaria did not reveal the presence of any others. Those numbers that were located are noted in the appended list by an asterisk. The authenticity of these specimens is definitely established by the fact that each contains a note in the peculiar hand-printing used for labels by M. A. Curtis in which the numbers, names, and localities correspond to those in the original list (1). Furthermore, the notes in the publication (1) stating that there were in the collection but one specimen of No. 13, and but two of No. 31, and the agreement of the figure of No. 31, fig. 8, (1) with the specimen absolutely eliminates any doubt respecting these two instances. According to the instructions of J. K. Paulding (10), then Secretary of the Navy, to Commander Wilkes, "You will require from every person under your command the surrender of all journals . . . as well as all specimens, etc.," it would appear that it was the intention to keep all specimens entirely under governmental care; and doubtless the fungi were in charge of Berkeley and Curtis only during their study. This would explain the apparent absence of any of these types from other herbaria[2] and a consequent lack of reference to them in the literature.

It is thus seen that all the types (possibly *in sensu stricto*) with the exception of No. 20, *Favolus platyporus,* are preserved. It is worthy of note that Berkeley and Curtis (1) considered No. 13, *Polyporus brunneolus,* to be similar to the type, giving it a significant status. The orthography of the list is that of the publication (1).

[2] Through the courtesy of Mr. Arthur W. Hill, Assistant Director of the Royal Botanic Gardens, it has been learned that none of these types is at Kew.

* 1. *Agaricus* (*Pleuropus*) *lagotis* Berk. & Curt. Oahu, Sandwich Islands.
2. *Agaricus ignobilis* Berk. Feejee Islands.
* 3. *Agaricus* (*Flammula*) *croesus* Berk. & Curt. Waya-ruru Bay, New Zealand.
4. *Agaricus* ——. Mauna Kea, Hawaii, Sandwich Islands.
5. *Cantharellus aurantiacus* Fries. Fort Vancouver. Oregon.
* 6. *Lentinus wilkesii* Berk. & Curt. Feejee Islands.
7. *Schizophyllum commune* Fries. Sandwich Islands.
8. *Lenzites repanda* Fries. Samoan Group, Navigators' Islands.
* 9. *Trametes australis* Fries, var. Mangsi Islands.
10. *Trametes lactea* Berk. Woolongong, New South Wales.
11. *Polyporus perennis* Fries. Island of Madeira.
12. *Polyporus sanguineus* Fries. Brazil; also Feejee and Mangsi Islands.
*13. *Polyporus brunneolus* Berk. Samoan Islands.
*14. *Polyporus flabelliformis* Klotsch. Sandal-wood Bay, Feejee Islands.
15. *Polyporus australis* Fries. Ovolau, Feejee Islands.
16. *Polyporus cinnabarinus* Fries. Feejee Islands, New Zealand, and New South Wales.
*17. *Polyporus vellereus* Berk., var. *poris minoribus*. Puget's Sound, Oregon.
*18. *Polyporus liturarius* Berk. & Curt. Ovolau, Feejee Islands.
19. *Polyporus* (*imperfectus*). Samoan Grop, Navigators' Islands.
20. *Favolus platyporus* Berk. & Curt. Feejee Islands.
*21. *Thelephora lamellata* Berk. & Curt. Feejee Islands.
*22. *Thelephora aurantiaca* Pers. var. Samoan Group, Navigators' Islands.
*23. *Thelephora scabra* Berk. & Curt. Ovolau, Feejee Islands.
24. *Stereum lobatum* Fries. Bay of Islands, New Zealand.
25. *Stereum complicatum* Fries. var. Ovolau, Feejee Islands.
26. *Exidia hispidula* Berk. New Zealand, Sandwich, and Mangsi Islands.
27. *Batarrea phalloides* Pers. Oregon.
28. *Lycoperdon pusillum* Batsch. var. Bay of Islands, New Zealand.
29. *Clathrus* (*Laternea*) *triscapus* Fr. Relief Bay, Fuegia.
30. *Hypoxylon concentricum* Bolt. Volcano of Maui, Sandwich Islands.
*31. *Hypoxylon pilaeforme* Berk. & Curt. Oahu, Sandwich Islands.

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CLITOCYBE SUDORIFICA AS A POISONOUS MUSHROOM

J. W. Roberts

On October 15, my wife collected some mushrooms which were growing on the Hall at Washington. I identified them as belonging to the genus *Clitocybe,* probably *Clitocybe dealbata.* In order to determine whether or not they were edible, I took a few nibbles just before dinner on the evening of October 15. No ill results were noticed. The next morning before breakfast, I ate one entire cap without any feeling of discomfort resulting. That night at dinner my wife and myself ate about eight or ten each. Those eaten at this time were creamed. We thought we noticed no ill effects but I remember that I perspired more freely than usual and remarked to my wife that the lights in a nearby apartment house had a peculiar appearance. However at the time I attributed the former to the fact that the heat was turned on in our apartment and the latter to peculiar atmospheric conditions. Since the flavor of these mushrooms was very pleasant more of them were collected on the morning of October 18 and served with meat that evening at dinner. My wife ate something like eight of them and I ate probably twice that number.

At about 6:45, or one half hour after dinner, I began to feel very warm and was perspiring very freely. At about 7:00 o'clock my eyes began to give out and I was compelled to stop reading. At 7:30 I looked at my watch and had some difficulty in telling the time. At 8:20 I was so warm and perspiring so freely that I opened the outside door of the apartment and put on lighter clothing. Shortly afterward my wife came in from another room and said she was not feeling well. I mentioned that I could read no longer for despite my glasses which magnify slightly, I was unable to see clearly. She at once said that she could not see distinctly. To both of us all objects appeared blurred. Lights appeared as sun-bursts of remarkable beauty.

This derangement of sight was due to the contraction of the pupils.

Realizing that the trouble was due to mushrooms, a physician was summoned. He arrived shortly before 9:30. Before his arrival we had taken emetics to good effect. He gave additional emetics and bits of mushrooms were among the things brought up.

I was also, beginning at about nine o'clock, affected with diarrhoea. At about the same time my muscles began twitching and by nine-thirty I had very little control of my legs and arms. I was, for instance, unable to pick up a glass of water with one hand. There was also a very pronounced flow of saliva and my clothing were soaked with perspiration. There was a scantiness of urine, in fact none was voided between 6:00 o'clock that evening and 9:00 o'clock the next morning, at which time less than two ounces was given off. My pulse was rapid, being about 90, whereas it is usually around 70. Respiration was, I believe, about normal, at least I do not recall having any difficulty in breathing, or being troubled with shortness of breath.

After the physician was satisfied that the stomach was empty, purgatives were given and atropine was administered subcutaneously. We were then ordered to bed under heavy covering and with hot water bottles at our feet. Within a short time, I should say half an hour, I had recovered control of my muscles and was experiencing a mental exhilaration. I enjoyed the peculiar appearance of the lights and glistening objects and told the doctor and the nurse that I felt better than I usually did when well.

At 2:00 o'clock the next morning I went to sleep, awakening at 6:00 and again at 9:00. At 9:00 I arose and looked over the morning paper with eyesight apparently normal. My wife complained of pain at the top of her head but I felt no pain anywhere. In fact, save for my wife's headache neither of us had felt any pain throughout the whole experience. Both of us were in possession of our mental faculties throughout.

During the day following I was as usual save for scantiness of urine, scantiness of saliva and lack of sense of taste. Pulse, perspiration, sight, etc., were apparently normal.

By the next afternoon, October 20, the flow of urine became normal or nearly so, but the scantiness of saliva persisted a day longer.

My sense of taste, I have not yet fully regained at this date, October 22, the fourth day after the mushrooms were eaten. There was no after effect of stupor or coma with slowing up of the heart beat.

On October 20, specimens of the mushroom were submitted to Miss Vera K. Charles, who very kindly identified it for me. Miss Charles also cited me to Murrill's note on this species as follows:

Clitocybe sudorifica Peck, Bull. N. Y. State Mus. 157: 67. 1912.

First described as a variety of *C. dealbata* from specimens collected in grassy ground at Saratoga, New York, by F. G. Howland. It has been collected in two or three other localities in Albany and Ontario counties. Mr. Howland, Dr. Peck, and Dr. W. W. Ford all agreed that this mushroom was decidely sudorific and unwholesome, differing decidedly in this respect from the reputation enjoyed by *C. dealbata*. I have examined the types, however, and can see no morphologic difference between the two plants. They both grow gregariously in exposed grassy places and the best observer could not tell them apart.—Murrill, W. A. In Mycologia 7: 274–275. 1915.

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OBSERVATIONS ON THE INFECTION OF CRATAEGUS BY GYMNOSPORANGIUM[1]

J. F. Adams

An interesting growth of the red cedar (*Juniperus virginiana*) and hawthorns (*Crataegus* spp.) is found on the slopes of Tussey Mountain at Mussers Gap, Center County, Pennsylvania. They comprise the shrubbery growth within an old cleared area of twenty-five acres, now used for a pasture, which is surrounded by

Fig. 1. A dense growth of hawthorns as it appears in early spring.

a secondary growth of oak trees. In certain areas the hawthorns are close together and form a very dense growth, as shown in figure 1. The cedars and hawthorns are often found associated as shown in figure 4. The majority of the cedars, however, are in rather restricted groups surrounding the hawthorns. Thirteen specimens of hawthorns have been identified in this area. Several trees of *Malus glaucescens* have been found also adjacent to this

[1] Contribution from the Department of Botany. The Pennsylvania State College, No. 25.

section. Whatever the conditions, they have been very favorable for the prolific reproduction of the hawthorns and illustrate an interesting development of recognized species.

With the close association between the two hosts favorable conditions are present for the development of *Gymnosporangium* rusts. The following species are found established: *Gymnosporangium germinale* (Schw.) Kern, *Gymnosporangium globosum* Farlow, and *Gymnosporangium Juniperi-virginianae* Schw. These three species are found severely infecting the above mentioned hosts.

FIG. 2. Upper portion of a hawthorn showing the numerous hypertrofied branches as the result of infection of *G. germinale*.

The telial infection of *G. germinale* which occurs upon the trunks and branches of the cedars is most prevalent on the young growth, which is often completely girdled. On the hawthorns the most serious infection is with this rust. The young growth, modified branches, and terminal buds present abnormal hypertrofied developments when infected, as shown in figure 3. Severely infected trees with this species of rust present, from a distance, an appearance similar to a black-knot infection on

plums. Figure 2 shows the upper growth of a hawthorn in the early spring with the numerous hypertrofied branches as the result of previous infection. On the larger branches the hypertrofies indicate perennial character of the rust infection. The aecia on the branches always preceed the appearance of the aecia

FIG. 3. A branch showing the hypertrofied development of the young growth, modified branches and terminal buds as the result of infection by *G. germinale*.

on the fruit of the hawthorns. Infection with *G. germinale* on the fruit of the hawthorns is most conspicuous and the fruits are usually completely covered with the cylindrical aecia.

Infection with *G. globosum,* which occurs on the leaves of the hawthorns, has been observed to cause partial defoliation. The aecia are also commonly found developing on the calyx lobes of

the fruits. The aecia of *G. Juniperi-virginianae* were found only on the fruit and leaves of *Malus glaucescens*.

Specimens of these rusts have been collected at different times within this area by Dr. F. D. Kern, Prof. C. R. Orton and the writer. The different species of *Crataegus* have been kindly identified by Prof. W. W. Eggleston. The following list includes

FIG. 4. An intimate association between cedar and hawthorn favorable for the development of the rusts.

those species of hawthorns not previously reported as hosts in North American Flora for *G. germinale* and *G. globosum*. There are ten additional species reported for *G. germinale* and six for *G. globosum*. The remaining species of hawthorns listed includes those not previously reported for Pennsylvania.

Through the kindness of Dr. J. C. Arthur I have secured the data regarding a collection which was not reported in North American Flora, but was collected previous to our collection at Mussers Gap, Center Co., Pennsylvania. The collection is in the exsiccati of Ellis, *North American Fungi 1084,* as *Gymnosporangium germinale* on *Crataegus coccinea* collected in West Chester, Pennsylvania.

Gymnosporangium germinale (Schw.) Kern

on

Crataegus coccinea[1] L.
Crataegus coccinioides[1] *Ashe.*
Crataegus Jesupi[1] Sarg.
Crataegus macrosperma[1] Ashe.
Crataegus Margaretta[1] Ashe.
Crataegus neofluvialis[1] *Ashe.*
Crataegus pausiaca[1] Ashe.
Crataegus pruinosa[1] (Wendl.) Beadle.
Crataegus punctata[2] Jacq.
Crataegus straminea[1] Beadle.
Crataegus succulenta[1] Schrad.

Gymnosporangium globosum Farlow

on

Crataegus Calpodendron[1] Borckh.
Crataegus coccinea[2] L.
Crataegus coccinioides[2] Ashe.
Crataegus Crus-galli[2] L.
Crataegus Jusupi[1] Sarg.
Crataegus macrosperma[1] Ashe.
Crataegus Margaretta[2] Ashe.
Crataegus neofluvialis[1] Ashe
Crataegus pruinosa[2] (Wendl.) Beadle.
Crataegus straminea[1] Beadle.
Crataegus succulenta[1] Schrad.

Gymnosporangium Juniperi-virginianae Schw.

on

Malus glaucescens[2] Rehder.

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[1] Species not previously reported in North American Flora.
[2] Species not previously reported from Pennsylvania.

THE FRUIT-DISEASE SURVEY

W. A. Murrill

(With Plate 3)

Encouraged by the success of the field meeting on Long Island in 1919 for the study of potato diseases, the American Phytopathological Society decided to hold a similar meeting in 1920 for the study of fruit diseases. The region selected was the Great Valley, extending from Staunton, Virginia, northward into Pennsylvania, one of the richest and best known fruit-growing districts in the United States; and the time was the first week in August, which proved to be a most fortunate selection because of the perfect weather.

Early Monday, August 2, phytopathologists began to arrive at Staunton from all parts of the country, as well as from several foreign countries, until about 75 had assembled; the attendance being further augmented by horticulturists, entomologists, and other specialists. The mornings and afternoons were devoted to inspection work and the evenings to informal discussions of the fungi causing the diseases observed and the various methods of control. No better method could be devised for meeting the problems which pathologists have to face, and, in my opinion, the meeting under discussion was the greatest in the history of plant pathology.

I have prepared a popular account of this survey for the Garden *Journal;* and Dr. G. R. Lyman, who was mainly responsible for its success, has published a brief report on it in the November number of *Phytopathology.* The following paragraph is taken from his report.

August 3 was devoted to a tour of the Staunton-Harrisonburg district in Virginia, and included the inspection of interesting demonstrations of apple root-rot and cedar rust, and comparative dusting and spraying experiments for control of various apple

diseases. The party spent August 4 in Berkeley County, West Virginia, noting the effects of cedar eradication, visiting orchards where dusting and spraying experiments were in progress, and inspecting demonstrations of collar-blight and other diseases. Visits were also made to the experimental packing plant at Inwood, and to the West Virginia pathological weather instrument station near Martinsburg. August 5 was spent in the vicinity of Hagerstown, Maryland, and was largely devoted to peach diseases and their control by dusting and spraying, some attention also being given to truck-crop diseases. On August 6, the party visited the Field Laboratory of the Pennsylvania Agricultural Experiment Station at Arendtsville, Pennsylvania, and inspected experiments in progress in that region under direction of the laboratory staff on the control of apple diseases and insects. The conference adjourned at Gettysburg, but on August 7 a portion of the party continued by automobile to Philadelphia, visiting the rich agricultural districts of Lancaster County and inspecting the tobacco experiments in progress there.

Wednesday evening, we were guests of the Chamber of Commerce of Hagerstown, Maryland. After the usual exchange of courtesies, the representatives of foreign countries were called upon for addresses, beginning with Dr. Brierly, of England; after which Dr. Ball, Assistant Secretary of Agriculture, Prof. Symons, of the University of Maryland, and other speakers entertained us until nearly midnight.

Thursday was another full day. We visited truck gardens to study blights, rots, mosaics, tip-burns, etc.; peach orchards to observe the effects of spraying; apple orchards for cedar eradication; and the Antietam battlefield for its historic interest. In the evening, there was a meeting for the discussion of local fruit diseases held under the auspices of the Washington County Fruit Growers, at which Prof. Whetzel discussed dusting and spraying, and Mr. Charles Repp, of New Jersey, outlined some of the difficulties of the commercial fruit-grower of the present day.

We shall never forget the informal talk given by Dr. Brierly in the peach orchard Thursday morning. The audience sat on a shaded, elevated terrace looking out on a wonderful valley, while

the speaker gave an immensely interesting account of the plant diseases in England. Silver-leaf was very bad on apples, plums, etc., while Nectria canker and brown-rot were among their worst orchard diseases. Potato-wart was terrible, often taking 100 per cent. of the crop. Dr. Brierly said this was the only case he knew in which the host was either entirely susceptible or entirely immune. The mycological flora of the soil was also touched upon as an exceedingly important field of investigation.

The accompanying photograph, showing a number of those in attendance, was taken at Arendtsville, Pennsylvania, after a 35-mile drive over the mountains through the Mt. Alto State Forest of 25,000 acres.

The visit to Gettysburg was greatly enjoyed, and another excellent photograph was taken which I should like to reproduce if space allowed. The effects of shot and shell on forest trees were much in evidence on the battlefield, where one white oak was noticed with 18 bullet-marks in the lower part of its trunk. In a low spot in the forest, near a spring, the white ash trees were all seriously affected with a heart-rot caused by *Fomes fraxinophilus,* many sporophores of this fungus being observed on the trunks.

The meeting Friday evening, at Gettysburg, was devoted to impressions, results, plans for the future, and a general summing-up of the phytopathological situation. Prof. C. R. Orton presided and called upon Jones, Waite, Ball, Whetzel, Brierly, Lyman, and others to make impromptu addresses on various subjects. It was the general opinion that the meeting had been a most decided success.

On Saturday morning, a number of the pathologists, including Brierly, Foëx, Rosatti, Stevenson, Bain, Whetzel, Kern, Adams, Orton, Torrey, and others, journeyed by automobile from Gettysburg to Lancaster and thence by trolley to Ephrata, where Mr. Olsen showed the co-operative experiments on tobacco being conducted by the U. S. Department of Agriculture and the Pennsylvania Agricultural Experiment Station. At the farm of Professor E. K. Hibshman, the visitors saw numerous strains of tobacco growing under the ideal conditions of this region. The

A PHOTOGRAPH TAKEN AT ARENDTSVILLE, PENNSYLVANIA

experiments included not only a tobacco strain test but also studies on various fertilizers and rotations. In connection with the field studies, difficulty has been encountered with the root-rot disease caused by *Thielavia basicola* and the plant pathologists of the Pennsylvania Agricultural Experiment Station have been called in to assist in testing the various strains of tobacco for resistance to this disease. This season, six strains were being tested on infested and noninfested soil and marked differences were noted. One strain is apparently highly resistant, though not immune, to root-rot. It will produce a good crop beside other strains which will be a total failure.

Dr. Lyman was fortunate in having such able and obliging associates on his committee of arrangements. Fromme was in charge in Virginia, Giddings in West Virginia, Temple in Maryland, and Orton in Pennsylvania. Dr. Waite represented the Department of Agriculture.

NEW YORK BOTANICAL GARDEN.

NOTES AND BRIEF ARTICLES

[*Unsigned notes are by the editor*]

Readers of MYCOLOGIA are invited to contribute to this department personal news items and notes or brief articles of interest to mycologists in general. Manuscript should be submitted before the middle of the month preceding the month in which this publication is issued.

Dr. C. D. Sherbakoff is now plant pathologist at the Tennessee Experiment Station.

The new officers of the Pacific Division of the Phytopathological Society are Dr. H. S. Reed, Dr. J. W. Hotson, and Dr. S. M. Zeller.

Mr. Stewart H. Burnham has removed his extensive collection of New York plants to Cornell University, where he will be permanently located.

Dr. Foëx, representing the pathologists of France, visited the Garden on September 8; and Dr. Brierly, representing those of England, spent October 8 with us and departed for Rothamsted October 9.

A memorial of the late Professor P. A. Saccardo has been prepared and distributed by Professor de Toni. Nearly half of the pamphlet of 36 pages is devoted to a list of Professor Saccardo's publications.

Professor Samuel M. Tracy died at Laurel, Mississippi, on September 5, at the age of 73. He was born at Hartford, Vermont, and educated at the Michigan Agricultural College. Several of his publications deal with the fungi, and he was associated with Professor Earle in studies of the fungous flora of the southern states.

Thomas F. Hunt, Dean of the College of Agriculture of the University of California, has accepted appointment as permanent delegate representing the United States at the International Institute of Agriculture, Rome, Italy. His wide knowledge of agricultural conditions in America, coupled with his extensive investigations in Europe, make him an exceptionally well-qualified man for this position, which has been vacant since the death of David Lubin.

Mr. Ramsbottom, general secretary of the British Mycological Society, with headquarters at the British Museum, has undertaken to compile a list of all the new genera of fungi published since the appearance of Vol. XXII of Saccardo's "Sylloge," the original diagnoses of which will appear in annual instalments in the Society's publications. He will welcome separates including descriptions of new genera or any other assistance that will make his work easier or more complete.

Dr. L. O. Overholts, of State College, Pennsylvania, arrived at the Garden, August 28, with several boxes of specimens to be studied and compared in the mycological herbarium. Among them were some specimens which we were very glad to see, including types of certain species recently described by Mr. C. G. Lloyd. Of these, *Polyporus induratus* C. G. Lloyd, collected at Urbana, Illinois, in 1918 by William McDougal, proves to be a rather thick form of *Fomes fraxineus,* which is more like the typical European specimens than most of those I have seen from America.

Grifola flavovirens was found in quantity at Yama Farms, on September 6, by several members of the Mycological Club who were out collecting fungi. It appeared in several fine clusters in a low, damp spot in oak-chestnut woods between the Inn and Jenny Brook. I have never before seen so much of this rare species in one place.

Under the title "Selecta Mycologica," in the *Annales Mycologici* for 1920, Bresadola describes 92 new species of fungi from various localities and appends a list of observations and synonyms prepared during his study of herbarium material borrowed from several European institutions.

Dr. W. H. Ballou brought to the Garden on August 30 and September 2, from White Plains, New York, a number of interesting fleshy and woody fungi which he had just collected—among them *Lactaria atroviridis, Lactaria Indigo,* several species of *Boletus,* a peculiar form of *Tyromyces caesius,* zygospores of *Sporodinia grandis,* and a resupinate polypore.

Pestalozzia scirrofaciens is described as new by Miss Nellie Brown in *Phytopathology* for August, 1920, as the cause of a hard tumor on the stems of the sapodilla tree in Florida. The disease can be controlled in an orchard by destroying the infected trees.

Mr. H. A. Lee, pathologist of the Bureau of Science, Manila, reports banana wilt in certain parts of the Philippine Islands. Fortunately, this disease, caused by *Fusarium cubense,* has not yet appeared upon *Musa textilis,* which yields the valuable Manila hemp of commerce.

A mosaic disease of corn in Porto Rico similar to that found on sugar-cane, is described and figured by Brandes in the *Journal of Agricultural Research* for August 16, 1920. The corn aphis is an active agent in disseminating this disease; and the only known method of control is the destruction of infected plants.

"The Ascomycetous Fungi of Human Excreta," by C. E. Fairman, issued July 30, 1920, is a small illustrated pamphlet containing historical matter, observations, a bibliography, a list of the 18 species previously known, and the description of a new species, *Cylindrocolla faecalis,* found by the author in September, 1917.

Dr. Fairman is a practising physician and became interested in these fungi because of the connection of some of them with human diseases.

Professor Bruce Fink wrote me, August 29, from Conway, Kentucky, where he spent the summer: "The woods are full of fleshy fungi, as we have had wet weather. On August 21, I picked up a strange fungus, which I suppose is a Cyclomyces. It was growing at the base of an old stump in the woods. I found one somewhat like it near here several years ago. The two are the only ones I have collected." A specimen sent for the Garden herbarium proved to be the rare *Cycloporus Greenei,* as Professor Fink suggested.

A bacterial canker of poplar, caused by *Micrococcus populi,* has become a veritable scourge in the valley of the Oise and neighboring valleys of France. It attacks the stem and branches of seedlings and the trunks of older trees. Treatments are preventive only, and include selection of stock and locality, destruction of all insects feeding on the poplar, and destruction of all diseased trees or parts of such trees.

Professor Buller has published in the *Transactions of the British Mycological Society* for September, 1920, an interesting account of the way in which the red squirrel of North America collects mushrooms and stores them up in late autumn for winter use. They are either hidden away in quantity in holes in tree trunks, in crows' nests, etc., or placed in the forks of branches, where they dry quickly and may be used when desired.

A circular on Potato Wart distributed by the U. S. Department of Agriculture in October, 1920, reviews what was previously known regarding this very serious disease and adds information recently obtained by observation and experiment. A general discussion of the subject by Lyman is followed by special discussions of susceptible varieties and new hosts contributed by Kunkel.

The disease has been found on several varieties of tomatoes. The actual damage to this new host is slight, but the fungus is kept alive and spread to new fields by this means.

The Tropical Research Laboratory of the United Fruit Company, which was formerly located at Zent, Costa Rica, and closed during the period of the war, is being reopened at Changuinola, Panama. Dr. John R. Johnston, professor of plant pathology in the University of Havana, has been appointed director of tropical research for the company with headquarters in Havana, and two pathologists will be located at the Laboratory in Panama, one to continue work on the banana disease, and the other to work on the diseases of the coconut, cacao, and other crops.

Referring to *Pucciniastrum arcticum* (Lagh.) Tranz. the statement has recently been made that "Outside of Alaska only two American collections are known." (Bull. Torr. Bot. Club 47: 468) [Oct., 1920]. This statement needs amplifying. There are in the herbarium of the University of Wisconsin specimens representing 30 collections from upwards of 20 localities in Wisconsin ranging from the north to within about 40 miles of the southern boundary. All of these are on *Rubus triflorus* (*R. pubescens*) and all of the specimens on this species of *Rubus* are of the *arcticum* type while all of those on *Rubus strigosus* are of the *americanum* type. This raised a query as to whether the cause of the difference lay in the parasites or in the hosts.

J. J. DAVIS

"Collar-rot of Apple Trees in the Yakima Valley," by J. W. Hotson, is an important contribution to this subject published in *Phytopathology* for November, 1920. The author believes that the only essential condition of collar-rot is a permanent wound of the bark at the collar of the tree; which may be caused by *Bacillus amylovorus, Armillaria mellea, Polystictus versicolor,* gophers, frost, plowing, gradual corrosion by oxidation, etc. Where the injury is severe, the tree should be removed; in other

cases, cut out the diseased tissue, disinfect the wound with lysol and leave it exposed to the air. Bridge grafting has been tried on valuable trees, but can not be recommended as a general practice, since trees so treated are rarely thrifty.

In Bulletin 222 of the Connecticut Agricultural Experiment Station, Dr. Clinton gives an account, with illustrations, of new and unusual plant injuries and diseases found in Connecticut, 1916–1919. Under Dry Rot, on page 398, he describes a house at Westbrook, which was attacked by *Merulius lacrymans* and seriously damaged because of insufficient air drainage about the woodwork. Among the remedial measures suggested were: The removal and burning of all infected wood and rubbish; the creosoting, if possible, of the new wood used; and the building of several sunken areaways, protected only by wire netting, to allow free access of air under the house. According to Dr. Clinton, the dry-rot fungus depends in great measure for its development upon a fairly small and tightly closed air space next the wood, and a sufficient amount of water to keep the air therein constantly saturated or at least above the normal amount.

The results of experimental work and observations on the citrus canker by Peltier and Frederich are published in the *Journal of Agricultural Research* for July 15, 1920. The following statements are quoted from the summary:

The successful inoculation of a large number of wild relatives in the greenhouse shows that *Pseudomonas citri* has a wide range of hosts and is not limited to the genus *Citrus*.

So far as the menace of citrus-canker to the citrus industry of the United States is concerned, with the exception of *Poncirus trifoliata*, none of the wild relatives, native or introduced, now growing in the citrus districts are susceptible enough to have any bearing on the eradication program.

Leaf texture is apparently an important factor in influencing resistance to *Pseudomonas citri* by its host plants. This phase deserves further investigation.

An exceedingly important discussion of sugar-cane root disease by Earle and Matz appeared in the *Journal of the Department of Agriculture of Porto Rico* for January, 1920. A summary of the situation in Porto Rico is given by Earle, as follows:

> Root disease as here understood is a complex including phases often known as Root Rot, Wither Tip, Top Rot and Rind Disease. These phenomena are caused by a number of facultative parasites, none of which attack actively growing vigorous tissues. There is also a heretofore unknown true parasite inhabiting the vascular bundles. *Rhizoctonia* and *Pythium* are the usual root-killing agents rather than *Marasmius* and *Himantia.*
>
> Cane varieties differ greatly in their resistance or susceptibility to Root Disease. The Otaheite or Cana Blañca is very susceptible. North Indian canes like Kavangire and those with part North Indian parentage are very resistant or practically immune.
>
> Remedial or preventive measures include
>
> *A.* The planting of resistant varieties.
>
> *B.* Better cultural methods to overcome facultative parasites.
>
> *C.* Proper seed selection and handling.

The parasite inhabiting the vascular bundles is described by Matz as *Plasmodiophora vascularum.* It is said to differ from *P. brassicae* in having larger spores, in not forming galls, and in inhabiting the vascular system of its host, plugging up the conducting vessels and greatly interfering with their action.

A NEW BOLETE FROM PORTO RICO

Gyroporus Earlei sp. nov.

Pileus broadly convex, solitary, 8–10 cm. broad; surface slightly viscid when young, becoming dry at maturity, subglabrous, fulvous; margin thin, concolorous; context fleshy, firm, yellowish-white, unchanging, taste mild, but slightly mawkish; tubes sinuate-depressed, minute, ochraceous at maturity, not stuffed when young; spores ovoid to ellipsoid. smooth, honey-yellow under the microscope, with a very large nucleus, 7–8 × 4–5 μ; stipe somewhat enlarged above and below, bright-yellow at the apex, otherwise very dark brown, almost black, glabrous. solid, firm, 5 cm. long, 1.5–2 cm. thick.

Type collected in sandy land beside a ditch in an old grapefruit grove,—where the trees were dying from root disease,—near Manati, Porto Rico, October 29, 1920, *F. S. Earle.* The description is largely drawn from field-notes accompanying the collec-

tion. Boletes are exceedingly rare in tropical regions. This is probably the first specimen of the group that has been found in Porto Rico; and it is interesting to note that it belongs to the small genus having pale, ellipsoid spores.

W. A. MURRILL.

Tree Surgery is the subject of Farmers' Bulletin 1173, by J. Franklin Collins, published in September, 1920. This bulletin is intended primarily as a guide for those who desire to take care of their own trees or to superintend such work. It outlines some of the better methods of treating injuries, removing dead or diseased limbs, and repairing decayed spots in the trunk or limbs.

A badly diseased or injured tree should be removed and replaced by a healthy one unless there is some very special reason for trying to preserve the tree. This applies particulary to an old tree that has been in poor condition or in poor soil for some years. Such a tree rarely recovers completely from the shock of extensive or elaborate repair work on the trunk; in fact, it often deteriorates more rapidly thereafter. Two axioms of tree-repair work (tree surgery) that should be borne in mind constantly are (1) that prompt treatment of freshly made wounds is the surest and most economical method of preventing disease or decay in the future and (2) that all wounds made in tree-surgery work should be cleaned, sterilized, and protected from infection just as thoroughly as in the case of animal surgery and for exactly the same reasons.

At present tree-repair work has not received the recognition and approval from tree owners that it deserves. This may be due at times to unfavorable experiences with dishonest and ignorant tree surgeons, at other times to the reluctance of the owners to spend much money in preserving their trees, or from their ignorance of the benefits that may result when tree-repair work is properly done. Reliable tree surgeons are doing much in a practical way to educate the public as to the benefits of tree-repair work. Unfortunately, the unscientific or dishonest work of some others still is doing much to offset it.

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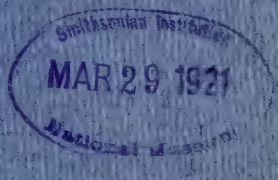

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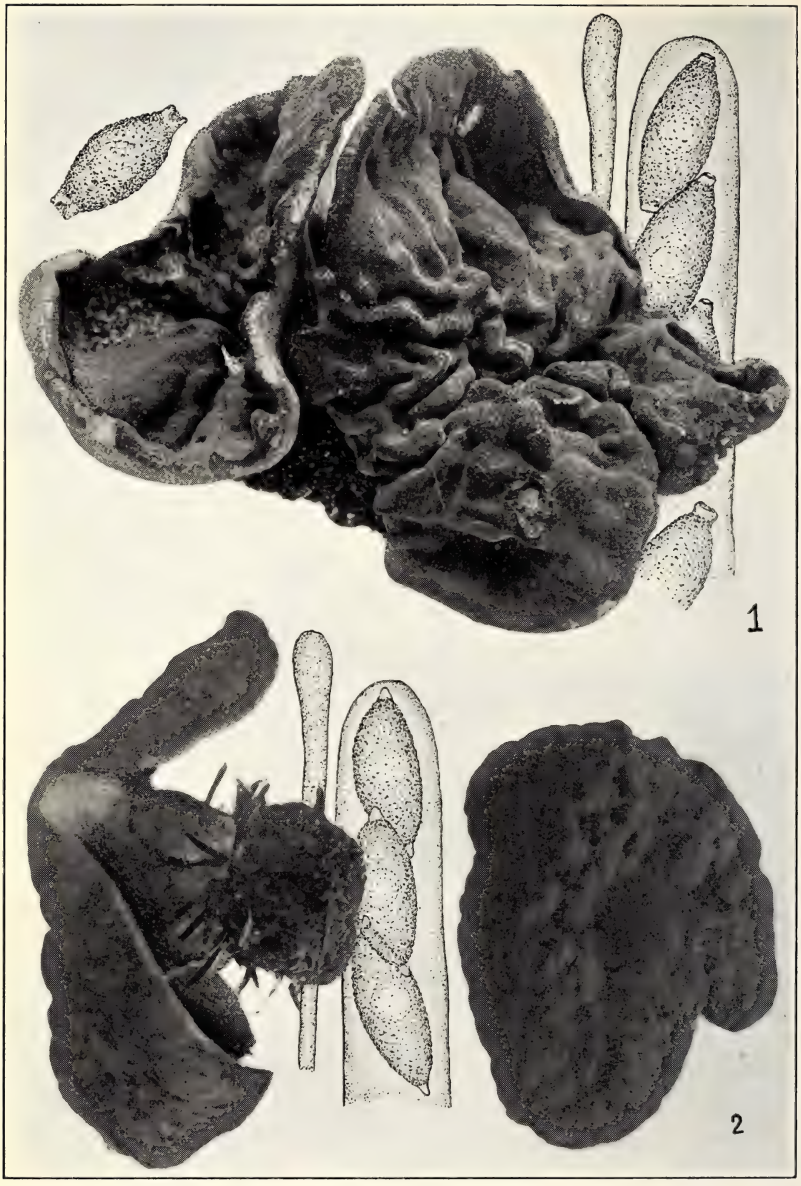

1. DISCINA CONVOLUTA Seaver

2. DISCINA ANCILIS (Pers.) Sacc.

MYCOLOGIA

VOL. XIII MARCH, 1921 No 2

PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—IX

NORTH AMERICAN SPECIES OF DISCINA

FRED J. SEAVER

(WITH PLATE 4)

The genus *Discina* was established by Fries in 1849 as a monotypic genus, having been segregated from the old genus *Peziza* and based on *Peziza perlata* of Fries which, so far as we can see, is identical with *Peziza ancilis* of Persoon. The species is characterized by the thick waxy consistency and the expanded form of the apothecia. The spores of the species also furnish important diagnostic characters, although these were not mentioned by Fries when the genus was proposed. The spores are unusually large, strongly roughened at maturity, and provided with an apiculate appendage at either end.

Although the genus originally contained a single species, it has been gradually enlarged until at present it contains a score or more of species. In fact, almost every species which shows a tendency to become repand or flattened has finally come to be placed in the genus *Discina*.

After an extended study the writer, while recognizing the genus, is inclined to use it in a more restricted sense to include those large forms of cup-fungi which have appendiculate spores since the spore characters are more fixed and reliable than the mere form of the apothecia which is so susceptible to change. The genus would then include comparatively few but well marked species.

[MYCOLOGIA for January (13: 1–65) was issued February 3, 1921]

The type species, *Discina ancilis,* a large and conspicuous fungus, is frequently collected from New York State west to Washington. A number of specimens have been received from J. R. Weir to whom the writer is indebted for the accompanying photograph. *Peziza Warnei* was described by C. H. Peck from material collected at Oneida, New York, by H. A. Warne. Examination of some of this material in the herbarium of the New York Botanical Garden shows it to be identical with *Discina ancilis.*

Discina leucoxantha is also a large and attractive species but is less frequently collected. It is readily recognized by its light color and by the truncate appendages which mark the spores. Several specimens have been received from Stewart H. Burnham, collected at Hudson Falls, New York. Other specimens from New York and Maryland have been examined. *Discina convoluta* differs in its extremely convolute hymenium. Whether this character is constant must be determined by future collections.

Peziza apiculate of Cooke also doubtless belongs to *Discina* as here treated although the occurrence of this species in North America is somewhat doubtful. A very small specimen collected by B. O. Dodge in Bermuda has been doubtfully referred to this species. Also *Peziza elaeodes* of Clements seems to agree although no specimen has been seen. Doubtless other apiculate spored species of cup-fungi occur in North America and it is hoped that more will come to light. A synopsis of the North American species follows:

37. DISCINA Fries, Summa Veg. Scand. 348. 1849

Apothecia medium to large, sessile or short-stipitate, fleshy or waxy, light or dark-colored; asci cylindric or subcylindric, very long, usually showing a tendency to become spirally twisted; spores ellipsoid, appendiculate and often sculptured, hyaline or faintly colored; spore appendages apiculate or truncate; paraphyses rather stout.

Type species, *Discina perlata* Fries.

Apothecia dark-colored; spore appendages apiculate.
Apothecia large, 6–7 cm. or more in diameter. 1. *D. ancilis.*

Apothecia medium sized, not exceeding 1.5 cm. in diameter. 2. *D. apiculata.*

Apothecia bright-colored; spore appendages truncate.

Hymenium strongly convolute. 3. *D. convoluta.*

Hymenium even or only slightly undulated. 4. *D. leucoxantha.*

1. DISCINA ANCILIS (Pers.) Sacc. Syll. Fung. 8: 103. 1899

Peziza ancilis Pers. Myc. Eu. 1: 219. 1822.
Peziza perlata Fries, Syst. Myc. 2: 43. 1822.
Discina perlata Fries, Summa Veg. Scand. 348. 1849.
Rhizina helvetica Fuckel, Symb. Myc. Nacht. 2: 66. 1873.
Peziza Warnei Peck, Ann. Rep. N. Y. State Mus. 30: 59. 1878.
Aleuria ancilis Gill. Champ. Fr. Discom. 36. 1879.
Acetabula ancilis Lamb. Fl. Myc. Belg. 2: 573. 1880.
Discina Warnei Sacc. Syll. Fung. 8: 102. 1889.
Discina ancilis Sacc. Syll. Fung. 8: 103. 1889.
Discina helvetica Sacc. Syll. Fung. 8: 103. 1889.

Apothecia gregarious or scattered, more rarely congested, short-stipitate, at first subglobose, soon becoming discoid, finally repand, at first regular in form, becoming irregular and often angular as the margin rolls back, externally whitish or pallid, reaching a diameter of 7 or 8 cm., or in rare cases as large as 20–25 cm.; hymenium uneven, often beautifully veined or convolute, plane or convex, usually umbilicate, dark-brown, finally almost black; stem very short and stout, often 1–3 cm. in diameter and rarely exceeding 1 cm. in length, or entirely wanting, more or less lacunose, whitish or overcast with a pinkish tint; asci cylindric or subcylindric, reaching a length of 300–350 μ and a diameter of 12–18 μ, 8-spored; spores obliquely 1-seriate, very large, ellipsoid, hyaline, 12–14 $\times$ 30–35 μ, or occasionally as long as 40 μ including apiculi; at first smooth, becoming sculptured; spore-sculpturing consisting of minute warts; spore appendages consisting of a minute apiculus 4–5 μ long and 3–4 μ broad at the base, one at either end of the spore; paraphyses strongly enlarged above, closely adhering together, dark yellowish-brown, reaching a diameter of 8 μ.

On the ground in coniferous woods, more rarely on rotten wood.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York to Washington, Oregon, and Colorado; also in Europe.

ILLUSTRATIONS: Ann. Rep. N. Y. State Mus. **30**: *pl. 1, f. 19–21*; Boud. Ic. Myc. *pl. 252*; Fuckel, Symb. Myc. Nacht. **2**:

f. 24; Pat. Tab. Fung. *f. 596*; Cooke, Mycographia *pl. 103, f. 371*; Rab. Krypt.-Fl. 1^3: 922, *f. 1–4*.

EXSICCATI: *Shear,* New York Fungi **324**: N. Am. Fungi *2622*.

2. **Discina apiculata** (Cooke) Seaver, comb. nov.

Peziza apiculata Cooke, Mycographia 175. 1877.
Phaeopezia apiculata Sacc. Bot. Centr. **18**: 218. 1884.
Aleuria apiculata Boud. Hist. Class. Discom. Eu. 47. 1907.
? *Peziza elaeodes* Clements, Bot. Surv. Nebr. **5**: 6. 1901.

Apothecia scattered, sessile, at first cup-shaped, soon becoming discoid, fleshy, circular in outline not usually exceeding 1.5 cm. in diameter; hymenium dark brownish-black, slightly concave or nearly plane; asci cylindric or subcylindric, reaching a length of 200 μ and a diameter of 18 μ, 8-spored; spores obliquely 1-seriate, with the ends overlapping, narrow-ellipsoid to fusoid, often with a small apiculus at either end, becoming pale brownish and often delicately sculptured, about 10 $\times$ 24 μ, containing two large oil-drops; spore sculpturing consisting of minute warts; paraphyses slender, adhering together at their apices, dark-brown.

On damp soil.

TYPE LOCALITY: Italy.

DISTRIBUTION: (Nebraska?) and (Bermuda?); also in Europe.

ILLUSTRATIONS: Cooke, Mycographia *pl. 79, f. 305*.

3. **Discina convoluta** Seaver, sp. nov.

Apothecia gregarious or cespitose, very short-stipitata, becoming shallow cup-shaped or subdiscoid, externally whitish at the base, becoming yellowish upwards toward the margin, reaching a diameter of 6 cm.; hymenium yellowish-brown, very deeply convolute, the convolutions consisting of more or less radiating ribs or veins, resembling those of *Peziza venosa* but more distinct; stem very short and stout, 1 cm. or more thick and usually not more than 1 cm. long, whitish, deeply corrugated; asci cylindric or subcylindric, reaching a length of 400–500 μ and a diameter of 20 μ, 8-spored but a part of the spores often remaining undeveloped; spores 1-seriate, with the ends usually overlapping, ellipsoid, becoming sculptured and appendiculate, 12–14 $\times$ 35–40 μ; spore-sculpturing consisting of warts or short interrupted ridges which often approach very fine reticulations; spore appendages consisting of a cup-like structure at each end; paraphyses stout, usually straight, reaching a diameter of 8 μ at their apices, densely filled with yellow granules.

On the ground in woods.

Type collected in the woods near Yonkers, New York, May 22, 1916, by F. J. Seaver.

DISTRIBUTION: Known only from the type locality.

4. DISCINA LEUCOXANTHA Bres. Rev. Myc. 4: 212. 1882

Peziza leucoxantha Bres. Fungi Trid. 42. 1881.

Apothecia gregarious or substipitate, at first subglobose, expanding and becoming hemispheric or nearly plane, externally whitish, reaching a diameter of 4–7 cm., the margin regular or lobed; hymenium concave or nearly plane, even or undulated, bright-yellow or becoming yellowish-brown with age; stem about 1 cm. in diameter and scarcely exceeding 5 mm. in length, irregularly corrugated at the base, the flesh thick and brittle; asci cylindric or subcylindric, attenuated at the base, reaching a length of 400 μ and a diameter of 20 μ, becoming twisted, 8-spored; spores ellipsoid, smooth, containing one large oil-drop and several smaller ones, becoming minutely sculptured, 10–15 $\times$ 27–35 μ; spore-sculpturing consisting of minute warts or occasionally minute ridges or indistinct reticulations; spore appendages consisting of truncate protuberances, one at either end of the spore; paraphyses slender, septate, branched, slightly enlarged above, filled with orange granules.

On the ground in coniferous woods.

TYPE LOCALITY: France.

DISTRIBUTION: New York; also in Europe.

ILLUSTRATIONS: Bres. Fungi Trid. *pl. 44*; Bull. Soc. Myc. Fr. 3: *pl. 12*; Boud. Ic. Myc. *pl. 253*; Rab. Krypt.-Fl. 1[3]: 922. *f. 5.*

NEW YORK BOTANICAL GARDEN.

DESCRIPTION OF PLATE 4

1. *Discina convoluta* Seaver. Two plants about natural size with drawings of a portion of an ascus with spores, paraphysis, and one spore isolated.

2. *Discina ancilis* (Pers.) Sacc. One plant showing the hymenial surface and one in profile both about natural size with drawing of a portion of an ascus with spores and paraphysis.

All drawings made with the aid of the camera lucida.

MASSOSPORA CICADINA PECK

A Fungous Parasite of the Periodical Cicada

A. T. Speare

(With Plates 5 and 6)

Among the enemies of the periodical cicada, *Tibicina septendecim* (L.), none perhaps is of more interest than the fungus *Massospora cicadina*. It is of interest because to perpetuate itself upon a host of such extraordinary life habits, and so far as is known it occurs on no other host, it must likewise possess a very unusual mode of life. It is of interest also because its relationship to other entomogenous fungi has not been clearly understood up to the present time, and, like many other entomogenous forms, it is worthy of especial consideration because it attacks an insect of some economic importance.

Although the organism was apparently first observed by Leidy (1850), the first description of it was published by Peck (1879). It seems probable that Peck observed the resting spores of the fungus as well as its conidia, but apparently he did not observe the processes associated with the formation of either of these types of reproductive bodies, and, lacking the information that a study of such stages would have afforded him, the organism was erroneously placed near *Protomyces* among the *Coniomycetes*. Thaxter (1888) almost simultaneously with Forbes (1888), published a brief note in which the fungus was considered as a member of the Entomophthorales, but as only a few old dried specimens were available for study at the time, none of which showed the resting spores, he apparently did not feel fully justified in assigning it to this family of fungi.

In addition to the above mentioned papers, several others have appeared such as those of Butler (1886) and Marlatt (1907), in which the gross appearance of the fungus and of the diseased cicadas was briefly described, but with the exception of the above

mentioned brief note of Thaxter no other publication has appeared, as far as the writer is aware, in which the microscopic characters of the fungus have been considered.

Like the host which it parasitizes, *Massospora cicadina* is, so far as is known, peculiar to America, and as a result, Europeans, to whom the fungus is known only by such fragmentary and incomplete references as those noted above, have been more or less confused in regard to the nature of the organism, Lakon (1919a), for example, classing it with *Sorosporella agrotidis* Sor. (*Sorosporella uvella* (Krass.) Gd.) and *Massospora staritzii* Bresadola as "Unvollkommen bekannte Entomophthoreen bezw. als solche beschriebene Pilze."

During the summer of 1919, Brood X of the periodical cicada made its appearance in the vicinity of Washington, D. C., and an excellent opportunity was thus afforded the writer to study its fungous parasite. The later was first observed on May 31, about ten days after the first insects emerged from the earth, and from this date until the disappearance of the brood in the early part of July it was constantly present, though in no great abundance until after June 10.

The resting spore as well as the conidial condition of the fungus was common about Washington, in 1919, but the latter was never as abundant as the former, and while it was often a difficult matter to collect during an afternoon a dozen cicadas showing conidia, during as many hours later in the season it was not difficult to collect hundreds of specimens showing the resting spores. It should be noted, that both types of reproductive bodies were never found either simultaneously or consecutively in the same individual, and it was determined that the conidia and the resting spores occurred at different periods in the aërial life of the host, the former appearing exclusively in the early part of the season, the latter developing toward the end of the aërial existence of the insect. It should be noted furthermore that the fungus seemed to be largely though not exclusively confined to the male insects. Despite the fact that infected insects were observed and collected many times during the season, not more than half a dozen parasitized females were observed. Whether or not the

disproportionately large numbers of infected male individuals indicates a predisposition of the latter to attack by *Massospora cicadina* has not been determined but the present instance is not the only one of the kind for Giard (1888) records the same phenomenon in connection with a fungus upon *Tipula paludosa*, which he appropriately called *Entomophthora arrenoctona*.[1] Nevertheless it is a rather unusual condition and one that has not yet been satisfactorily explained. Not only is present fungus largely confined to male insects but in the resting spore condition at least, it seems furthermore, to parasitize spent individuals in most instances. In the closing days of the brood, when the females were busy ovipositing in the tree tops, it was observed that simultaneously, the males occurred by hundreds, either dead upon the ground, or alive and feebly attempting to crawl from the ground up the trunks of trees. A very large percentage of such males were found upon examination to show the fungus parasite in some stage of resting spore development. It seems reasonable to conclude, as the large numbers of dead and dying males were found at a time when the females were laying eggs, that fertilization of the females had taken place in most instances and that the dead and dying males were largely spent individuals. It is not possible, however, to state whether or not the dead male insects found in early, or mid-season, in which it will be recalled conidia only occurred, had mated, but in any event such individuals were relatively few in numbers.

An examination of the healthy as well as the infected male insects, particularly toward the end of the brood, showed that the anterior portion of the abdomen was invariably empty. The genitalia and nearly all of the other internal organs were concentrated in the last four or five segments of the abdomen. This condition was also observed by Mr. R. E. Snodgrass of the Bureau of Entomology, who found furthermore that a sac was

[1] It is perhaps appropriate at this time to point out that Dr. Roland Thaxter, of Harvard University, who possesses the type of *Entomophthora arrenoctona* Giard, believes this fungus to be identical with *Entomophthora caroliniana* (Thaxt.). Although both descriptions were published in 1888, that of Thaxter appeared in April, and that of Giard some time after July 11. Hence the name *Entomophthora caroliniana* (haxt.) is the correct one and should be used for the fungus in question.

formed in the anterior portion of the abdomen which upon enlargement and inflation pushed the genitalia to the position indicated, and also pushed the intestine which normally in most insects lies close to the ventral abdominal wall to a position upon the dorsal wall. This sac becomes so large that it occupies the greater part of the abdomen, and in the opinion of Mr. Snodgrass it may act as an air reservoir in both sexes, and in addition, in the male, have a resounding function for the stridulatory apparatus. In any event a portion of the wall of this sac forms a septum across the body cavity, effectually separating the genitalia and other organs from the empty anterior portion of the abdomen, and the fungus which lives entirely upon the softer tissues of the insect's body is therefore limited in its development to the last four or five segments of the body in which the genitalia and other similar organs are concentrated.

As the conidial and the resting spore conditions do not occur simultaneously in the same individual and as the insects in which conidia are formed present quite a different appearance from those in which resting spores occur, it seems advisable to consider each phase of development separately.

CONIDIAL DEVELOPMENT

Infected individuals showing the conidial stages of the fungus appear in a way such as is illustrated on Plate 5, Fig. 1.[2] Specimens such as those shown, were usually found lying dead upon the ground beneath trees, or in open roadways, although very often a similarly afflicted cicada was observed flying around in an unsteady manner, or crawling feebly about. Unfortunately no specimens showing an earlier phase of the disease were collected, and therefore while the method of formation of the conidia was followed in several instances, an earlier stage homologous to the "hyphal body" stage of other Entomophthorales was not observed.

The fungus thus confined in its vegetative growth to the softer

[2] In the specimens shown the wings and legs were removed artificially in certain instances, in order better to expose the fungus mass for photographic purposes, and in the individuals shown on Plate 5, Fig. 2, a portion of certain of the abdominal rings was removed for the same purpose.

tissues in the posterior segments of the body of the host, ultimately destroys all such tissues, including the flexible intersegmental membranes of the abdomen in this region. As a result of the complete destruction of these membranes the posterior abdominal segments slough off until a condition such as that illustrated on Plate 5, Figs. 1 *B* and *C* is reached. The sloughing off process takes place progressively, beginning with the last segment and continues until four or more have been dropped, the last remaining one marking the position of the septum referred to above. The insect does not die at the time the first segments are dropped. On the contrary it remains alive for a considerable period and continues to fly and crawl about from place to place.

As far as the writer is aware such a sloughing off process, taking place while the host is alive, is quite unknown in other insects attacked by other members of the Entomophthorales, and in fact the phenomenon is so unusual that it has been noted by practically every person who has observed the disease in the field. The appearance of insects crawling and flying about with but two or three abdominal segments attached to the thorax, is indeed sufficiently striking to attract the attention of any one.

The fungus mass, including the conidia, which morphologically is of endogenous origin, becomes exposed as fast as the body segments of the host rot away, and the movements of the insect from place to place serve to disseminate the conidia in a way that could scarcely be improved by any natural method. It will be recalled that in most of the entomogenous entomophthorales, the conidia are borne upon conidiophores which bore their way outward through the body wall of the host, and that they are violently ejected from the conidiophores only after the host is dead and therefore stationary. Although the conidia are thrown to some distance, such a method seems inefficient when it is compared with the process which takes place in the present instance, in which the live, actively moving infected host mingles promiscuously with its fellows.

The fungus when intact forms a clay colored pustule like, granular mass at the tip of the abdomen. In certain individuals such as is shown on Plate 5, Fig. 1 *C* the pustule is quite large,

assuming the size and conformation of that part of the abdomen which it formally occupied. In other specimens Plate 5, Fig. 1 *B* and *D*, the pustule is asymmetrical and ragged. Such specimens as the latter are evidently old ones, from which a large part of the conidia were detached when the hosts were alive and moving about. Upon microscopic examination the pustule is found to be composed almost wholly of conidia, although if search is made deep within the mass close to the septum, conidiophores and the characteristic entomophthoroid hyphal fragments may also be seen.

As noted above, in the species of Entomophthora, the conidia are violently discharged from the conidiophores. In *Massospora*, however, the conidia are formed within the body of the host, and although they are cut off in the usual manner their ejection is prevented by the body wall of the insect, which when they are cut off is intact, and holds them in the approximate position in which they are produced. The conidia therefore cohere with one another and a mass is formed which upon disintegration of the intersegmental abdominal membranes is exposed, and assumes the form of a pustule such as is described above. The movement of the host at this period is perhaps the most important factor in loosening the segments of the abdomen, the membranes connecting which have been destroyed by the vegetative development of the fungus so that the movements of the insects not only serve to scatter the conidia of the fungus, but first free them from captivity.

The conidia are, so far as the writer has been able to determine, all of one type, which conforms in most respects to that of the other Entomophthorales. They are quite regularly oval in form, measuring 10–14 × 14–17 microns. The papilla, an outgrowth characteristic of the conidia of all members of the family, is usually not prominent, though always noticeable. Occasionally it stands out conspicuously in a manner such as is shown on Plate 6, Fig. *A*. Unlike other members of the family, however, the conidial walls are regularly verrucose, which condition renders them unique in appearance. It should be noted, however, that there is a tendency for them to lose the warted appearance if they are permitted to remain in water for a short time.

The method of formation of the conidia and the manner in which they are cut off seems quite like the analogous processes in other species and need not be discussed here.

When viable conidia were placed upon a slide in a moist chamber, or when they were sewn upon a nutrient agar, germination usually took place in a manner such as is illustrated on Plate 6, Figs. 2–3, namely, by one or more rather stout, long, germ tubes. Occasionally, however, a single rather stout germ tube arose, the terminal portion of which became swollen, Plate 6, Fig *D,* as though to form a secondary conidium, but at this point development invariably ceased.

In connection with the germination tests, attempts were made to grow the fungus artificially. The media used were potato agar, Molische's agar, oat agar, and nutrient beef broth. In addition to these nutrients, the genitalia and other organs, upon which the fungus normally grows in nature, were removed aseptically from live, healthy cicadas and employed without sterilization, for the same purpose. No growth of the fungus was obtained, however, upon either the unsterilized tissues from freshly killed insects, or upon the other nutrients noted above.

The conidia when placed in a suitable situation germinate with great rapidity, a growth such as that illustrated on Plate 6, Fig. *B–C,* taking place within three hours, but after such a short, rapid, preliminary growth development ceased in every instance in the writer's tests.

RESTING SPORE DEVELOPMENT

Up to the present time resting spores have not been definitely associated with the organism in question, although Peck (1879) vaguely described bodies, which Thaxter (1888) subsequently tentatively regarded as resting spores. In the light of these investigations furthermore, it likewise appears that many of the early notes about the fungus contain references to the resting spore condition, although the descriptions were of such a nature that they might have applied equally well to the conidial growth.

As noted above the resting spore condition, which was never found associated with the conidial condition, was very prevalent

about Washington in 1919, from 50–90 per cent of the male insects showing this stage of the fungus during the latter part of the season.

In its vegetative growth prior to the production of resting spores, the fungus destroys the intersegmental abdominal membranes of the host, as it does in the conidial phase of the development just considered, and there is a similar sloughing off of the abdominal segments. The septum described above, across the body cavity of the insect, which normally persists in insects affected with the conidial growth is, however, destroyed in most instances during the formation of the resting spores, and although these bodies arise upon the soft tissues concentrated in the last four or five posterior segments of the body, they may be found, owing to the absence of the septum, in some numbers, within the otherwise empty anterior portion of the abdomen.

The resting spore-mass which is, nevertheless, largely confined to the posterior segments, presents a granular appearance and is of a sulphur yellow color, tinged with green when young, but it assumes a dark brown color when the resting spores are mature. These bodies are less coherent in the mass than are the conidia, and as a result they are scattered about by the movements of the host much more freely. It was in fact not uncommon to observe an infected individual in which the empty body cavity formed one continuous passage from the last abdominal segment to the head, with two or three of its abdominal segments missing, actively crawling or flying about. In this respect the appearance of cicadas showing the resting spores, differs from those showing the conidial growth, because it will be recalled there occurs in the latter a persistent fungus stroma closely associated with the above-mentioned septum, which after the abdominal segments have been dropped, remains as a continuous partition across the abdomen.

It can therefore be readily seen that, though both of the reproductive phases have many characteristics in common, there are nevertheless certain characters by which one phase may be readily distinguished from the other merely by a superficial examination.

Microscopically the mature resting spores, or as they perhaps should be called, azygospores, appear as spherical, slightly brownish bodies, the outer wall of which is beautifully reticulated in a manner such as is shown on Plate 6, Fig. *T*. They are remarkably uniform in size, mesauring 38–48 microns in diameter, averaging 44 microns.

Unfortunately all stages in the development of these azygospores were not seen in fresh material and particularly those stages associated with the transfer of protoplasmic material from the byphal body to the resting spore. Alcoholic material, which it may be stated was all collected in the daytime, indicates, however, that the process is a non-sexual one, and that the azygospores arise as buds or outgrowths upon the hyphal bodies into which, as they enlarge, flows the entire protoplasmic contents of the hyphal body, the empty and evanescent walls of which sometimes remain attached to the mature resting spores.

The writer showed (Speare, 1912) in connection with *Entomophthora pseudococci* that the presence or absence of daylight, at the time of maturity of the hyphal bodies, predetermined to a large extent the type of reproductive body that was formed, and that the azygospores of the fungus in question, could be produced at will, by placing artificial cultures of the fungus in a dark situation a few hours before the hyphal bodies were ready to "germinate." It would therefore seem reasonable, if one desired to collect the early resting spore stages in such a similar form as *Massospora cicadina,* to search for them during the night, yet, inadvertently no collections were made at this time in the present investigation. Nevertheless, the alcoholic material shows with reasonable certainty that no sexual process is present, and that the development of the resting spores, conforms quite well with the development of the azygospores in other members of the family such as *Entomophthora aulicae* Reich.

The resting spores of *Massospora cicadina* like the analogous bodies of many other of the entomogenous species of the family have never been seen to germinate. In the writer's tests a number of them were heated at varying degrees of temperature, and a number were permitted to remain out-of-doors all winter, yet no

germination was observed, when, after such treatment they were suspended in a drop of water in Van Tieghem cells. Similar negative results were obtained in attempts to germinate resting spores that had previously been treated with dilute hydrochloric acid for a short time.

The writer has obtained no information in these studies regarding the manner by which *Massospora cicadina* passes the 16 years and 9 months' subterranean existence of its host. That it lives during this period either on the larvae of *T. septendecim,* or on other similar biennial cicadas seems the reasonable supposition, yet there is no evidence at hand to support this theory. It is probable that when it has been determined how, for example, *Entomophthora muscae* and other species that are not known to form resting spores, live over winter (see Lakon, 1919 *b*), information will be at hand that will be of value in solving the peculiar conditions involved in the present instance.

From the economic viewpoint it must be stated that if the fungus is confined largely to spent males and does not attack and kill the larvae (the writer observed it only on adult individuals), its importance as a natural check to the spread of this insect is almost negligible. Investigation should be made, however, of larvae two or three years before their emergence in order to determine whether or not the fungus is present.

These studies show, it is hoped, that there can no longer be any question regarding the relationship of *Massospora cicadina* to other entomogenous Entomophthorales, and that while it is a very distinct form in many respects, it falls quite naturally into the above mentioned family.

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EXPLANATION OF PLATES

PLATE 5

Fig. 1. Specimens of *Tibicina septendecim* showing the conidia of *Massospora cicadina*. Although certain organs of these insects were removed artificially, the abdomen with the attached fungus mass is shown in each instance exactly as it was observed in the field. Fig. 1*A* is a female individual and shows an unusually large conidial mass. × 1.

Fig. 2. Specimens of *Tibicina septendecim* showing the resting spores of *M. cicadina*. In Fig. 2*A* a portion of the anterior four abdominal segments were removed artificially. Fig. 2*B* shows the fungus mass within the abdomen, viewed from a posterior position. × 1.

PLATE 6

Figs. *A, E, F.* Conidia of *Massospora cicadina*. × 1048.

Figs. *B, C, D.* Conidia germinating. × 568.

Fig. *G.* Optical cross section of conidium showing its thick wall. × 1048.

Fig. *H.* A group of conidiophores. × 568.

Figs. *I, J, K, L.* Selected conidiophores showing the method of formation of the conidia. × 568.

Fig. *M.* Gourd shaped hyphal bodies associated with the resting spore condition. × 268.

Figs. *N, O.* Young resting spores with hyphal bodies attached. × 268.

Figs. *P, S.* Young resting spores with hyphal bodies attached. × 532.

Fig. *Q.* A stage in resting spore development intermediate between those shown in Figs. *P* and *T*. × 532.

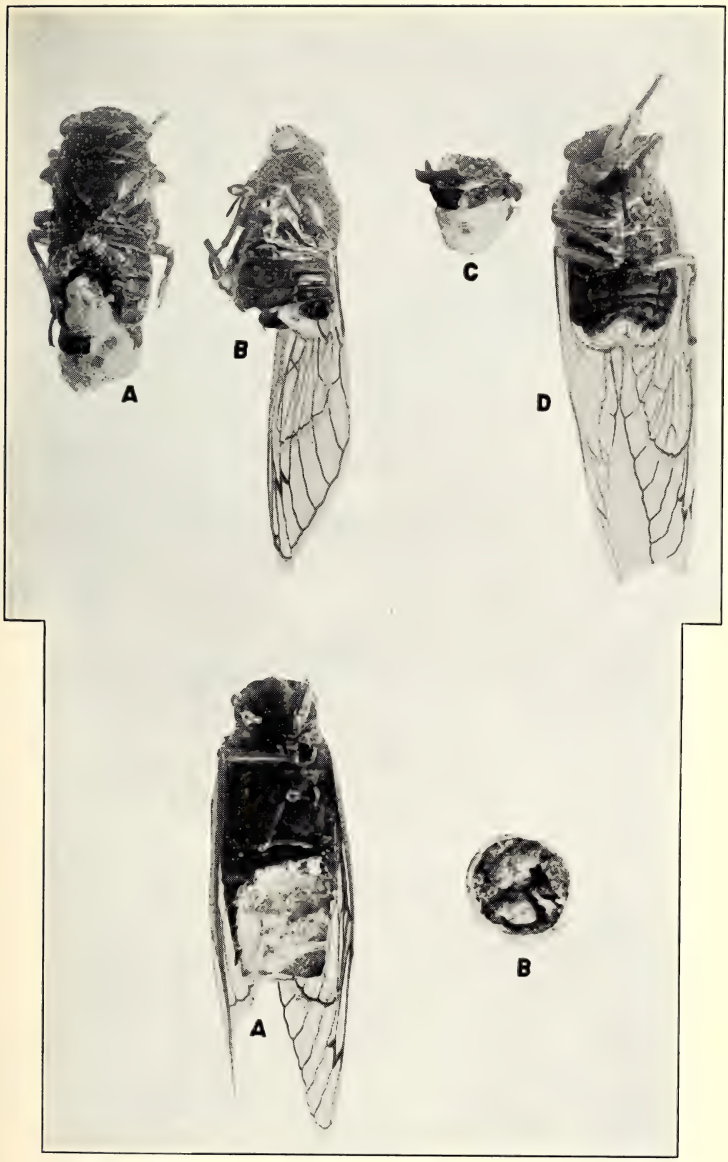
Fig. *R.* Apparently an encysted hyphal body. × 532.

Fig. *T.* Mature resting spore. × 568.

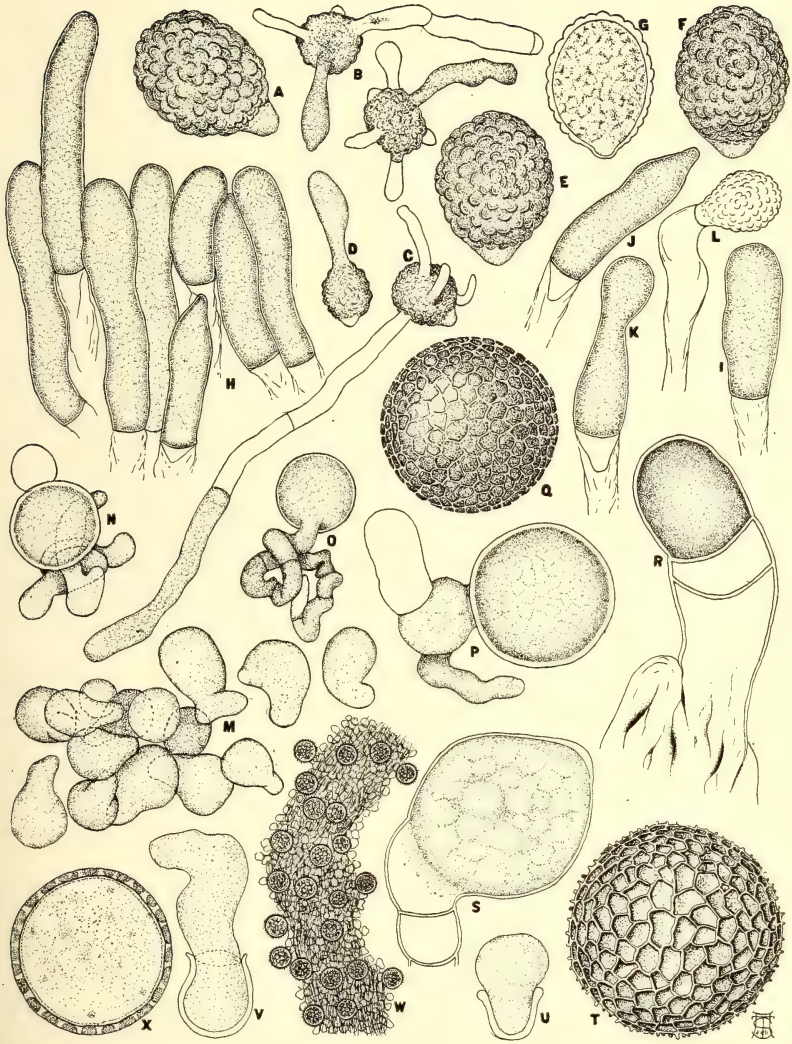
Figs, *U, V.* Hyphal elements of unknown origin and function found associated with the resting spore condition. × 568.

Fig. *W.* A portion of one of the tube-like genital organs, showing resting spores and hyphal bodies adhering. × 62.

Fig. *X.* Optical cross section of a resting spore in about the stage of development shown in Fig. Q. × 532.



1. (Above.) CONIDIA ON TIBICINA
2. RESTING SPORES ON TIBICINA



MASSOSPORA CICADINA Peck

LIGHT-COLORED RESUPINATE POLYPORES—III

William A. Murrill

The last number of this series, which appeared in Mycologia for November, 1920, dealt chiefly with white species. In the present article, I shall mainly discuss species that are rose-colored, lilac, red, or purple; or that show tints of these colors.

48. Poria eupora (P. Karst.) Cooke, Grevillea **14**: 110. 1886

Polyporus euporus P. Karst. Not. Sällsk. Faun. Fl. Fenn. **9**: 360. 1868.

Polyporus attenuatus Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 61. 1873; Ann. Rep. N. Y. State Mus. **26**: 70. 1874.

Polyporus Blyttii Fries, Hymen. Eur. 571. 1874.

Poria Blyttii P. Karst. Bidr. Finl. Nat. Folk **37**: 83. 1882.

Poria attenuata Cooke, Grevillea **14**: 110. 1886.

Originally described as follows from specimens collected on dead willow wood in Finland by Karsten, who notes that it is not rare:

"Effusus, adhaerens vel adnatus, tenuis, submicans, ambitu byssaceo-contextu albo; pori minuti, subangulati, demum saepius laceri, curti, testaceo-lutei."

The type of *P. Blyttii* is at Christiania. At Upsala I found two specimens under this name, one white and the other rosy-isabelline, the latter being the correct one. According to Bresadola, *Polyporus collabens* Fries and *P. emollitus* Fries are forms of *P. Blyttii* Fries, and his statement appears to be supported by original specimens in his herbarium. Specimens from Karsten show that *P. euporus* is not distinct. It may be that the name here used will have to give way to *P. nitida* Pers. See discussion under that species.

The most complete description of this fungus is that recently

published by Overholts, the various original descriptions being brief and inadequate. He finds the spores 3–4 x 2–3 μ and the cystidia 60–80 x 7.5–10 μ. Bresadola measured the spores as 4–4.5 x 2–2.5 μ.

This species occurs on linden, poplar, oak, birch, beech, willow, etc., in Europe; and in this country on maple, oak, witch hazel, alder, willow, linden, ironwood, and certain other deciduous trees. I have found it very common on red maple. A specimen from Bresadola collected by Eichler on *Pinus sylvestris* exactly agrees with ours on maple in gross characters, and Bresadola finds the spores to be the same, but the cystidia less abundant. Peck's variety *subincarnata* occurs on hemlock, but this is a distinct species.

Ellis, N. Am. Fungi *921*; Canada, *Faull 47, 49, Macoun 36 (177), 41, 121, 133, 141, 145, 223, 397, 458, 499*; Newfoundland, *Waghorne 691*; Maine, *Murrill 1747, 2010, 2167*; Vermont, *Burt*; New Hampshire, *Underwood*; Connecticut, *Underwood 550*; New York, *Cook, 93, Murrill 64, Underwood, Van Hook (Cornell University 7896), Van Hook & Smith (Cornell University 8067)*; Pennsylvania, *Everhart & Haines, Herbst, Sumstine 63*; Ohio, *James 10, Lloyd 379, 2788, 2789, 3116, Morgan 77, 81*; Indiana, *Underwood*; Iowa, *Holway 208*; Florida, *Calkins*.

49. PORIA VINCTA (Berk.) Cooke, Grevillea **14**: 110. 1886

Polyporus vinctus Berk. Ann. Mag. Nat. Hist. II. **9**: 196. 1852.
Polyporus carneopallens Berk. Hook. Jour. Bot. **8**: 235. 1856.
?*Polyporus Fendleri* Berk. & Curt. Jour. Linn. Soc. **10**: 317. 1868.
Polyporus epilinteus Berk. & Br. Jour. Linn. Soc. **14**: 55. 1875.

Described as follows from specimens collected by Sallé in Santo Domingo and still preserved at Kew:

"Totus resupinatus, centro crassiusculus margine tenuis subliberatus supra sanguineo-tinctus; poris minimis pallidis contextu lignicolori. Sallé, no. 34. On dead wood.

"Spreading for many inches over the decayed wood, 2 lines or more thick in the centre, very thin at the extreme margin, where the upper surface is separable, smooth, and stained with blood-color. Pores scarcely visible to the naked eye, pallid, a line or more long; dissepiments thin; substance wood-color."

P. carneopallens was described from Spruce's collections in Brazil, *P. Fendleri* from Fendler's collections in Venezuela, and *P. epilinteus* from Ceylon. According to Cooke, one of the original type specimens of the last species has orange mycelium while the two others are without it. *Poria cassicola* Bres., recently described from Brazil, is nearly related. *Poria lilacina* Speg., collected by Balansa in Paraguay, is apparently not distinct.

This species is rosy-isabelline when fresh, like *P. eupora,* with which it is easily confused. It occurs throughout tropical regions on dead wood of orange, acacia, etc., as indicated in the following collections:

Mexico, *Murrill 238, 622, 869, 976, 979, 1029, 1045, 1187, 1190*; Mexico or Nicaragua, *Smith 244*; Nicaragua, *Smith 65a*; Cuba, *Earle & Murrill 80, 210, 325, Horne 197, Underwood & Earle 1208*; Porto Rico, *Johnston 430, Johnston & Stevenson 1495, Stevenson 2888, 2910, 3362*; Danish West Indies, *Raunkiaer 138, 171, 188, 239, 249, 264*; Jamaica, *Underwood 3287, Murrill & Harris 942, Murrill 37, 184, 228, 247, 249, 373, Earle 100, 219*; Venezuela, *Fendler*; South America, *Gaillard 65*; Ceylon; also from New Zealand and Perak.

50. **Poria albirosea** sp. nov.

Effused for several centimeters, continuous, inseparable; margin appressed, membranous, white to rosy-isabelline, becoming inconspicuous with age; context pallid, a mere membrane; hymenium slightly uneven, not glistening, pallid to rosy-isabelline, becoming pale-chestnut-colored in spots when bruised or handled; tubes rigid, rather regular, angular, 3–4 to a mm., reaching 2 mm. in length, edges rather thin, entire; spores ovoid, smooth, hyaline, $5 \times 3\,\mu$.

Type collected on well-rotted deciduous wood at Fern Hollow, Pennsylvania, July 13, 1906, *David R. Sumstine 70.* Also collected at three different times on dead wood in Canada by *Macoun* (probably near Ottawa), and at Wilmington, Delaware, *Commons 2672.* Langlois' No. *2543,* from St. Martinsville, Louisiana, may belong here, but the tubes seem rather small.

51. **Poria subundata** sp. nov.

Effused for several centimeters, becoming continuous, closely appressed, inseparable, thin; margin inconspicuous, thin, appressed, white, soon disappearing; context pallid, not apparent in age; hymenium very oblique, beautifully undulated, not glistening, cremeous to pale-rosy-isabelline; tubes small, rigid, regular in size and shape, angular, 5 to a mm., 1 mm. or less long, edges thin, entire; spore characters not satisfactorily determined.

Type collected on a decayed standing stub of a hardwood tree in wet woods on Cooper's Ranch at the base of El Yunque Mountain, Baracoa, Cuba, March, 1903, *L. M. Underwood & F. S. Earle 1168*. Also collected on decayed hardwood in Troy and Tyre, Jamaica, January, 1909, *W. A. Murrill & W. Harris 1012*.

52. **Poria subincarnata** (Peck) sp. nov.

Poria attenuata subincarnata Peck, Ann. Rep. N. Y. State Mus. 48: 118. 1897.

Briefly described by Peck as follows, from specimens collected on fallen branches of *Tsuga canadensis* at Alcove, New York, by C. L. Shear in November, 1893:

"This differs from the typical form in the paler color of the pores. It grows on hemlock bark and forms small patches rarely more than 1 inch in diameter."

Overholts has described it at length after studying type material and specimens recently collected by himself in New Hampshire. He finds the spores allantoid, hyaline, 4–5 x 1 μ; cystidia none. I have a number of collections—on fir, hemlock, *Cupressus thyoides,* alder, maple, etc.—all of which appear to be identical with the type at Albany. Various specimens collected by me in Maine and New York appeared milk-white to buff with an incarnate tint when fresh and are now pale-rosy-isabelline in the herbarium. Thin forms of *Poria eupora* from Karsten collected on willow greatly resemble this species at first glance, but under a hand lens they show darker and more rosy tints, while the microscope reveals their strikingly different spore characters.

Ellis & Everhart, Fungi Columb. *1*; Canada, *Macoun 289, 570*; Newfoundland, *Waghorne 29*; Maine, *Murrill 1925 ,1985, 1988,*

1989; New Hampshire, *Underwood*; New York, *Murrill 2708, Shear*; New Jersey, *Ellis.*

53. **Poria Dodgei** sp. nov.

Widely effused, continuous, inseparable, thick; margin conspicuous, but narrow in age, appressed, membranous, pale-rosy-isabelline; context membranous, rosy-fulvous; hymenium even, somewhat glistening, rosy-isabelline to rosy-fulvous; tubes rigid, quite regular, angular, rosy-fulvous within at maturity, 2–4 to a mm., reaching 5 mm. in length, edges thin, subentire; spores elongate, smooth, hyaline, 5.5 x 2.5 μ.

Type collected on a decayed coniferous log at Krohns Lake, near Algoma, Wisconsin, by *B. O. Dodge.*

54. PORIA INCARNATA (Alb. & Schw.) Cooke, Grevillea **14**: 112. 1886

Boletus incarnatus Alb. & Schw. Consp. Fung. 250. 1805.
Polyporus incarnatus Fries, Syst. Myc. **1**: 379. 1821.

I have good specimens from Sweden and Trent, the latter collected by Bresadola on dead trunks of larch. Specimens from Florida sent to Ellis by Calkins and determined by Cooke as this species were compared by me with material at Upsala and found to be distinct. Underwood, while at Kew, studied plants from South Carolina in this connection and said that they seemed the same as specimens from Sweden. *Poria Dodgei* is nearly related.

55. PORIA UNDATA (Pers.) Bres. Ann. Myc. **1**: 78. 1903

Polyporus undatus Pers. Myc. Eur. **2**: 90. *pl. 16, f. 3.* 1825.
Polyporus cinctus Berk. Outl. Brit. Fungol. 250. 1860.
Polyporus subliberatus Berk. & Curt. Jour. Linn. Soc. **10**: 318. 1868.
Polyporus Broomei Rab. Fungi Eur. *2004.* 1876.
Polyporus odorus Peck, Ann. Rep. N. Y. State Mus. **38**: 92. 1885. Not *P. odorus* Sommerf. Suppl. Fl. Lapp. 275. 1826; Fries, Elench. Fung. **1**: 90. 1828.
Poria nigrescens Bres. Atti Accad. Roverto III. **3**: 83. 1897.

This species, so common in America, is usually labeled "*Poria*

callosa" or "*Poria corticola,*" from both of which it is very distinct. Peck described it from specimens collected on spruce logs at Osceola, New York, and referred to its strong, disagreeable odor; but his name does not appear to have been known or used outside of the state herbarium.

The earliest tenable name applied to it seems to be that of Persoon, who described it from a specimen collected by Chaillet on dead wood. His colored figure shows the "waves" in the hymenium which suggested the name. Bresadola seemed to think in 1903 that Fries misapplied the name *Polyporus vitreus* Pers. to this species, and his opinion is supported by a specimen from Karsten collected on *Pinus sylvestris.* Another note I have from him, however, is to the effect that *Poria vitrea* Pers. is not specifically distinct from *P. undata,* but that the former is smooth and the latter an undulate variety. I see no difference between types of *Poria nigrescens* Bres. and specimens collected by Overholts at Oxford, Ohio. This blackening is not common and seems to be associated with thick, old forms which have "revived" the second or third year.

Fresh specimens are described as "pure-white," "yellow," "reddish-flesh-colored," etc., and as separating readily from the matrix. With specimens collected by Overholts on beech logs in Ohio are the following notes:

"Effused, separable, orbicular at first, then irregular, perennial, 2–3 mm. thick; margin thin, free, sterile, narrow, cottony, white; context inconspicuous; hymenium plane, gray, yellowish in weathered specimens; tubes stratified, pallid within, 2 mm. long each season; mouths circular, small, 6–7 to a mm., edges thin, entire; spores globose, smooth, hyaline, 3 μ in diameter."

Few species have such a wide distribution and find themselves at home on so many widely different hosts. Elm, beech, alder, orange, white oak, shingle oak, hemlock, spruce, fir, pine, Douglas spruce, and other trees are found mentioned as furnishing substrata for it; while the following list of specimens will indicate its distribution:

Barth. Fungi Columb. *5042*; Rab. Fungi Eur. *2004*; Zopf & Syd. Myc. Mar. *5*; England, *Plowright*; Finland, *Karsten*; Ber-

lin, *Braun, Hennings, Magnus, Sydow*; Hungary, *Kmet*; Canada, *Dearness 699B, 1113, 2046, Macoun 107*; New Hampshire, *Wilson*; New York, *Ames, Atkinson 22767, Ballou, Underwood, Van Hook (Cornell University 8255)*; New Jersey, *Ellis*; Pennsylvania, *Banker, Sumstine 1, 6, 16, 17, 19, 55, 56*; Delaware, *Commons 2673*; Ohio, *Gentry, Hard (Cornell University 19618), Lloyd 1728, Overholts 23, 70*; Indiana, *Underwood, Van Hook 2192*; Missouri, *Demetrio 629*; Arkansas, *Long 19834*; California, *Harper, Johnston 253, 255*; North Carolina, *Townsend (Cornell University 5734)*; Alabama, *Earle and Underwood*; Mississippi, *Bartholomew 5782*; Louisiana, *Langlois 48, 183, 1735, 2431*; Florida, *Calkins 853*; Cuba, *Earle 751, Horne 197, Underwood & Earle 745A*; Danish West Indies, *Raunkiaer 172*; Panama Canal Zone, *Bethel.*

56. PORIA BORBONICA Pat. Jour. de Bot. 4: 198. 1890

Originally described as follows from specimens collected on bark on Reunion Island:

"Résupiné, dur, compact, entièrement gris de souris, marge nulle. Tubes obliques, longs de 5 millimètres, implantés directment sur le support; pores petits, arrondis, ou ovales allongés, entiers, à cloisons minces. Mycélium blanc, floconneux, abondant, entourant la plante d'une large bordure soyeuse.

"Plante formant des plaques denses, larges de 10–20 centimètres. Le mycélium pénètre profondément dans l'écorce et donne naissance à des couches blanches à la manière du *Poria corticola.*"

This species is widely distributed and quite common in tropical regions on dead trunks of mango, cocoanut, etc. When young and fresh, the hymenium is very light russet with a glaucous bloom. The following specimens have been examined:

Cuba, *Baker 3885, Earle 265, 653, Earle & Murrill 338, 484, 492*; Porto Rico, *Britton, Brown & Cowell 5360, Johnston 678, Johnston & Stevenson 1502, 1606, Santingo 33*; Jamaica, *Earle 226, 547, 556, Murrill 14, 61, 139, 1124, 1144, Underwood 3470*; Danish West Indies, *Raunkiaer 128, 133, 135, 176, 195*; Montserrat, West Indies, *Shafer 902*; Guadeloupe, *Duss 7*; Africa, *Dusen.*

Owing to the difficulty in finding spores, I can not say positively that the specimens listed below from Florida and adjacent states are the same as those given above. They are very similar, but without the glaucous bloom, which may have been removed by some treatment to destroy insects.

Ellis & Everhart, N. Am. Fungi *2304*; Louisiana, *Langlois 1274, 1736, 1879, 2544, 2545, 2552*; Florida, *Calkins 20, 635, 644, 704.*

57. PORIA LATERITIA Pat. Bull. Soc. Myc. Fr. **15**: 200. 1899

Described as follows from specimens collected by Duss on a dead trunk of *Symplocos martinicensis* in Guadeloupe:

"Larges plaques dures, ligneuses, planes ou à peine bosselées, grises à la surface, rouge brique à l'intérieur; pores superficiels (100 μ de profondeur), très petits (50–65 μ de diamètre), anguleux-sinueux, irréguliers, à cloisons minces, rigides, de 20–30 μ d'épaisseur, grises dans leur portion libre avec la tranche blanchâtre, souvent incomplètes et prenant alors l'aspect irpicoïde. Trame épaisse de 1 à 3 millim., brique, dure, traversée par les cloisons.

"Espèce distincte de P. aurantiotingens par sa trame rouge brique et non brune ou noirâtre."

I have specimens from Duss (No *592*) collected on Symplocos and also a fine collection made on Fergus Mountain, Montserrat, January 30, 1907, *J. A. Shafer 886.* The latter specimens show the cinereous hymenial surface and the brick-red, stratose interior so characteristic of the species, as well as a handsome, smooth, dark-brown border encircling the fungus.

58. PORIA SANGUINOLENTA (Alb. & Schw.) Cooke, Grevillea **14**: 112. 1886

Boletus sanguinolentus Alb. & Schw. Consp. Fung. 257. 1805. *Polyporus sanguinolentus* Fries, Syst. Myc **1**: 383. 1821.

The only American specimen that appears to belong here is one collected on rotten wood at Ottawa, Canada, by Macoun, February 10, 1883. Ellis collected specimens on oak at Newfield, New Jersey, which resemble authentic material, but their identity

is in doubt. His N. A. F. *1306*, on cedar, seems to me distinct, although it was milk-white when young and fresh. Specimens collected by me on spruce near Stockholm, Sweden, in 1910, and determined by Romell, as well as by comparison with specimens from Karsten, were described by me in the field as follows: "Margin milk-white, slightly ragged and cobwebby; hymenium discolored at the center with brownish-chestnut tints as though bruised or stained with blood. The discolorations are not brilliant, however, but look more like old blood stains."

Bresadola reports the species from Hungary on poplar, beech, and walnut. Specimens from Poland on pine are said by him to be much thinner and quite distinct in appearance, being very similar to *P. violacea,* with which he says this form is often confused. According to him, the spores are 6–8 x 2–2.5 μ, and the hymenophore is at first white, then stained with red, drying incarnate, and becoming purple or violet-fuscous in the herbarium. His idea of the species is quite different from Romell's and Karsten's, and specimens so named from him appear very similar to *P. purpurea.*

Krieger, Fungi Sax. *421*; Roum. Fungi Gall. *3113*; Sweden, *Murrill*; Finland, *Karsten*; Belgium, *Bommer & Rousseau*; Saxony, *Krieger*; Canada, *Macoun 130.*

59. **Poria Bracei** sp. nov.

Widely effused over the soil or decayed organic matter, following the irregularities of the surface and reviving from year to year until it forms extensive mats a centimeter or more thick; margin very broad and conspicuous, membranous, persistent, pale-wine-colored to lilac or rose-colored; context conspicuous, becoming rose-bay with age; hymenium appearing in patches, but soon continuous and fairly even, roseous to darker, not glistening; tubes regular in size and shape, roseous to darker within, 1–2 mm. long each season, mouths circular, 4 to a mm., edges rather thick, entire; spores globose, hyaline, 4 μ.

Type collected on the bottom of a barrel at Nassau, New Providence, Bahamas, in 1918, *L. J. K. Brace 9594.* Also collected on dead wood at Nassau, December 15, 1918, *Brace 9764*; on the ground at Nassau, in 1904, *Brace 836½*; and on the

ground at Rio Piedras, Porto Rico, February 22, 1914, *J. R. Johnston & J. A. Stevenson 1427.*

60. PORIA VIOLACEA (Fries) Cooke, Grevillea **14**: 112. 1886

Polyporus violaceus Fries, Obs. Myc. **2**: 263. 1818.

According to Bresadola, this very rare species is scarcely known by mycologists, even Fries himself confusing it with other species. The color, he says, is constant, dilute-violet; subiculum exceedingly thin; tubes 2 to a mm., very short, resembling those of *Merulius*; spores hyaline, 5 x 2.5–3 μ. Specimens collected by him at Trent on *Abies* resemble very closely what I am calling *Poria purpurea,* but Bresadola says that the spores of the latter species measure 7–8 x 2–2.5 μ and are cylindric-curved. Specimens labeled *Poria violacea* by Ellis and others have a distinct subiculum and differ in other ways. See *Poria taxicola.*

61. PORIA PURPUREA (Hall.) Cooke, Grevillea **14**: 112. 1886

Polyporus purpureus Fries, Syst. Myc. **1**: 379. 1821.
Boletus lilacinus Schw. Schr. Nat. Ges. Leipzig **1**: 74. 1822.
?Polyporus oxydatus Berk. & Curt. Jour. Linn. Soc. **10**: 317. 1868.

This is No. 2274 in Haller's list of Switzerland plants, collected on beech logs. Specimens described by Schweinitz were collected in North Carolina. The distribution in America is indicated by the list of specimens below, many of which have been called *Poria micans* Ehrenb., a species not found in America, but, according to Bresadola, well represented by *P. albocarneo-gilvidus* Romell, collected on oak in Sweden and distributed by Romell. The American hosts of *P. purpurea* are red maple, magnolia, sycamore, live oak, and pine.

Canada, *Dearness 1075, Macoun 141*; New York, *Cook*; Pennsylvania, *Witte 38*; West Virginia, *Nuttall 223*; Ohio, *Lloyd 2811, Morgan 90*; Indiana, *Underwood*; Colorado, *Cockerell 76*; Kansas, *Bartholomew 2060, Kellerman & Swingle 1381*; Oregon, *Murrill 926*; California, *McClatchie 1071, Parish 2975, Parks 1022.*

In addition to the above, there are a few specimens which I can not definitely connect up with this species without having more stages. They appear to be young and are distinctly lilac in the dried state, with smaller tubes than those of typical *P. purpurea,* reminding one strongly of *Poria aurantio-canescens* P. Henn., found on poplar in Berlin.

Pennsylvania, *Murrill 1190*; Delaware, *Commons 2163*; Ohio, *Lloyd 3560, Morgan 325.*

62. **Poria subbadia** sp. nov.

Irregularly effused for several centimeters, becoming continuous, closely adhering, rather thin; margin thin, appressed, arachnoid, white to rosy-isabelline, inconspicuous with age; context white to rose-colored, at first a mere membrane on which the tubes appear in patches, scarcely apparent in mature specimens; hymenium very uneven, not glistening, testaceous to pale-bay in dried specimens; tubes irregular, angular, collapsing to some extent, 2–3 to a mm., 1 mm. long, edges thin, becoming lacerate-dentate; spores smooth, ellipsoid, distinctly roseous under the microscope, 5 x 3 μ.

Type collected by *L. M. Underwood* on a dead trunk at Auburn, Alabama, in February, 1896. Also collected in Bermuda on dead fiddlewood, December, 1912, *Brown, Britton, & Seaver 1418.*

63. PORIA MUTANS TENUIS Peck, Ann. Rep. N. Y. State Mus. 43: 39. 1890

Collected by Peck on spruce at Sevey, New York, in July. Little can be added to what Peck and Overholts have published about this plant until more mature specimens have been found and studied. After a careful examination of type material, I must conclude with Overholts that the variety seems quite distinct from *P. mutans,* being much thinner, softer, and differently colored. It differs from *P. purpurea* in color and in having a distinct subiculum; and from *P. taxicola* in color and in the shape of its tubes, although having a similar, well-developed subiculum. Compare *Poria nitida* Pers.

64. PORIA NITIDA (Pers.) Cooke, Grevillea **14**: 110. 1886

Boletus nitidus Pers. Obs. Myc. **2**: 15. *pl. 4, f. 1.* 1799.

According to Bresadola, Persoon's original plant is quite distinct from Fries' interpretation of it. An excellent specimen collected on pine in Poland was recently sent me by Bresadola and I find it strikingly similar to *Poria mutans-tenuis* Peck. The specimens so labeled in American herbaria are mostly confused with *P. eupora* and *P. vincta. Poria nitida crocea* Schw. at Paris from French Guiana is near *P. spissa.* In his paper on Poland fungi, Bresadola gives the following description of *P. nitida*:

"Subiculum ut plurimum manifestissimum, usque ad 6 mm crassum, aurantiacum, in magis evolutis basi album, in exsiccatis saepe roseum, ex hyphis crasse tunicatis, 3–6 μ crassis, conflatum; tubuli et pori carnosi, molles, colore primitus carneolo dein vitellino vel aurantio-incarnato, compressione vel tactu fuscescentes, mox collapsi; sporae hyalinae, oblongae, 5–6 x 2½–3 μ."

In opposition to Bresadola's opinion, I have a note made in Persoon's herbarium at Leiden in 1906 to the effect that *Poria nitida* Pers. is near, if not the same as, *P. attenuata* Peck, and that Bresadola did not see Persoon's specimens. This would make the Friesian interpretation of the species more correct and our American specimens so labeled would not be far wrong. If I could see Pers. Obs. Myc. **2**: *pl. 4, f. 1* (which is not in our library) and compare it with my plants, I believe I could settle this question. Persoon's description is of little use.

65. PORIA PAVONINA Bres. Hedwigia **35**: 282. 1896

Described as below from specimens collected at Blumenau, Brazil, by Dr. Möller. I have examined the types of this species in Bresadola's herbarium and there are good specimens in the Ellis Collection here. The color is very beautiful, varying from dark-lilac to pale-purple. The species is known only from Blumenau, Brazil, where it was collected three times by Möller. His no. 364, which is older than the other two collections, was incorrectly determined by Bresadola as *Poria favillacea,* a species described from New England.

"Late effusa, coriacea, adglutinata, vivide pavonina, expallens, margine obsoleto, subiculo, nullo; tubulis brevibus, 1 mm. longis; poris parvis, subangulatis; hyphis subhymenialibus, 2 μ.—Sporae non visae."

66. PORIA TAXICOLA (Pers.) Bres. Atti Accad. Rovereto III. 3: 80. 1897

Xylomyzon taxicola Pers. Myc. Eur. 2: 32. *pl. 14, f. 4, 5.* 1825.
Polyporus haematodes Rostk. in Sturm, Deuts. Fl. Pilze 4: 127. *pl. 62.* 1838.
Merulius Ravenelii Berk. Grevillea 1: 69. 1872.
Polyporus sorbicola Fries, Hymen. Eur. 570. 1874.
Serpula rufa pinicola P. Karst. Hedwigia 35: 45. 1896.

This beautiful purple, white-bordered species was originally described and poorly figured by Persoon from specimens collected by Chaillet on the trunks of a conifer. Standing as it does on the border line between *Merulius* and *Poria,* it has received a number of names, both in this country and in Europe. Most of the herbarium specimens in the *Poria* sheets are called either *P. violacea* or *P. incarnata* by Fries, Karsten, Plowright, Ellis, and others. Burt includes it in *Merulius,*—as did Persoon, —and I have no desire to alter this arrangement. The hymenium is often strikingly merulioid when young. The spores are allantoid, hyaline, 3.5–4.5 x 0.5–1.5 μ. It occurs on dead wood and bark of pine, spruce, fir, *Cupressus thyoides, Thuya occidentalis,* and other conifers. One specimen from Karsten is said to have been collected on a deciduous trunk.

Cooke, Fungi Brit. *409*; Ellis & Everhart, Fungi Columb. *1*; Ellis, N. Am. Fungi *1305*; Rav. Fungi Car. 4: *9*; de Thümen, Myc. Univ. *406*; England, *Eyre, Massee, Plowright;* Finland, *Karsten*; Sweden, *Murrill 611*; New York, *Earle 1653, Murrill 822*; New Jersey, *Ellis*; Pennsylvania, *Stevenson 463*; Minnesota, *Holway 234*; South Carolina, *Ravenel*; Louisiana, *Bethel.*

67. PORIA SUBRUFA Ellis & Dearness, Proc. Can. Inst. 1: 89. 1897

The type collection was made by Dearness at Granton, Ontario, in November, 1896, on a rotten beech log. Unfortunately, none

of the material is in very good shape to compare with *Poria mutans* or other near relatives. The description is as follows:

"Resupinate, effused, mostly in small patches 2–4 cm. across, inseparable, soft, juicy, creamy-white when fresh, becoming reddish when dry; margin thin, membranaceous, narrow, almost wanting. Pores round to sub-angular, ¼–½ cm. long, ¼–½ mm. wide, dissepiments thin, margin acute but not lacerate. Spores elliptic-oblong, 4 x 3 μ."

68. PORIA SPISSA (Schw.) Cooke, Grevillea **14**: 110. 1886

Polyporus spissus Schw. in Fries, Elench. Fung. **1**: 111. 1828.
Polyporus salmonicolor Berk. & Curt. Hook. Jour. Bot. **1**: 104. 1849. Grevillea **1**: 53. 1872.
Polyporus cruentatus Mont. Ann. Sci. Nat. **1**: 129. 1854.
?*Polyporus laetificus* Peck, Ann. Rep. N. Y. State Mus. **38**: 91. 1885.
Poria crocipora Cooke, Grevillea **14**: 110. 1886.
Poria phlebiaeformis Berk.; Cooke, Grevillea **15**: 24. 1886.

Originally described from Schweinitz' collections in North Carolina on hard trunks. Redescribed from Ravenel's collections in South Carolina on burnt wood, the authors supposing that Schweinitz sent a different plant to Fries under the name *P. spissus*. The original Schweinitzian description, however, calls for a plant with spadiceous tubes and Fries refers in his notes to distinct black lines and to its resemblance to the true *P. obliquus*, whose tubes are similarly oblique and somewhat spadiceous. Moreover, specimens in Hooker's herbarium were marked *P. spissus* by Schweinitz and excellent types of the same kind still exist in the Schweinitz herbarium.

P. phlebiaeformis is hardly mature enough to show its true characters. *P. laetificus* is also probably a young stage, the type material being sterile and too poor for comparison. When young, *P. spissa* is white, then pale-salmon-tinted with a whitish border. Ellis describes it as continuous for 2–3 feet, with a thin, narrow, subtomentose margin, showing at first only a faint tinge of salmon color, which becomes deeper and changes more or less to a dull-red in drying, turning reddish when bruised, and having a

very strong odor in drying; pores nearly round or subangular, 2–3 mm. long, resting on a separable substratum or membrane, which is of a soft, carnose nature, not very tough and about 1 mm. thick. The hymenium is stratose.

The range of this species is remarkable, as will be seen by examining the list of collections below. Among its hosts are apple, linden, red maple, ash, *Alnus rhombifolia,* old hymenophores of *Hapalopilus gilvus,* pine, and *Pinus radiata.*

Ellis & Everhart, Fungi Columb. *208*; Ellis & Everhart, N. Am. Fungi *1594*; Rav. Fungi Car. **1**: *18*; Canada, *Dearness 1114*; New York, *Ballou, Burnham, Cook, Underwood*; New Jersey, *Ballou, Ellis, Martin 102, Southwick*; Pennsylvania, *Anderson, Miss Clarke 1595, Everhart & others 279, Haines 58, Sumstine 33, 39*; Delaware, *Commons 2783*; Ohio, *Fink 17, Lloyd 1106, Morgan 327*; Indiana, *Underwood*; Michigan, *Johnson 631*; Missouri, *Demetrio*; Oregon, *Carpenter 43*; California, *Gardner 1095, Johnston 254*; North Carolina, *Schweinitz*; South Carolina, *Ravenel*; Cuba, *Wright 939*; Guiana; Ecuador, *Lagerheim 98.*

69. PORIA MUTANS Peck, Ann. Rep. N. Y. State Mus. **43**: 39. 1890

Polyporus mutans Peck, Ann. Rep. N. Y. State Mus. **41**: 77. 1888.

Described as follows from specimens collected by Peck on chestnut wood at Selkirk, New York, in August:

"Resupinate, rather thick, tough, following the inequalities of the wood; pores minute, rotund, short, buff-yellow or cream color, becoming dingy red or dull incarnate where wounded, the subiculum fibrous, changing color like the pores, the whole plant assuming an incarnate hue when dried."

There are also specimens at Albany collected at Croghan, Bolton, and Savannah, New York; and I have six specimens collected on chestnut elsewhere, three from Connecticut, one from New Jersey, one from Pennsylvania, and one from Canada. The other specimens listed below may also be from chestnut, but the host is not mentioned in any case.

This species is closely related to *Poria spissa* and may be easily confused with it in herbarium specimens. Mr. Overholts found the spores to be hyaline, 3.5–5 x 2.5–3.5 μ; cystidia none. In recently collected young specimens, I found copious spores measuring 3–4 x 3 μ. In a collection made a few years ago, the spores were ovoid, smooth, hyaline, 3.5 x 2.5 μ, and one flask-shaped, pointed, yellowish cystidium was found measuring 25 x 8 μ. *Poria saloisensis* P. Karst. seems closely related, but is probably nearer *P. spissa.*

Canada, *Dearness*; Connecticut, *Clinton, Earle 484, Graves*; New York, *Ballou*; New Jersey, *P. Wilson*; Pennsylvania, *Sumstine 5, 6, 10, 12, 14, 34, 66*; Virginia, *Murrill 389.*

70. PORIA INCRASSATA (Berk. & Curt.) Burt, Ann. Mo. Bot. Gard. 4: 360. 1917

Merulius incrassatus Berk. & Curt. Hook. Lond. Jour. Bot. 1: 234. 1849; Grevillea 1: 70. 1872.

Merulius spissus Berk. Grevillea 1: 70. 1872.

Polyporus pineus Peck, Ann. Rep. N. Y. State Mus. 41: 78. 1888.

Poria pinea Sacc. Syll. Fung. 9: 194. 1891.

This very interesting species, which has been carefully studied both by Burt and Overholts, may be readily recognized by its large, dark spores. It somewhat resembles *P. taxicola* in gross characters, but belongs decidedly to *Poria* rather than to *Merulius.* Curtis collected his original specimens on a pine stump in South Carolina, and Peck obtained his on pine at Selkirk, New York. The margin is whitish or yellowish and the hymenium dingy-white, becoming purple to black with age. The spores are fuscous, 7.5–11 x 4–7 μ, and there are no cystidia.

In addition to the original specimens already mentioned, which I have seen at Albany, Kew, and elsewhere, I find several specimens in the Ellis Collection that represent stages not shown in the types. One of these collections is assigned a manuscript name by Ellis and the following notes accompany it: "Margin narrow, erect, tomentose, white, the edges fringed with short, spine-like hairs or bristles; mouths of tubes white, dull-reddish within;

spores allantoid, hyaline, 10–12 x 3.5 μ." This collection was made on dead limbs of *Pinus austriaca* at Newfield on Christmas day. Four other packets collected by Ellis on pine at Newfield bear as many different dates, and three are referred by him to *Poria violacea.*

The following specimens resemble those of the above species, but prove to be undeveloped resupinate forms of *Tyromyces Smallii* Murrill:

Auburn, Alabama, *Earle,* on pine bark; Newfield, New Jersey, *Ellis,* on old pine stump.

71. PORIA SUBVIOLACEA Ellis & Ev. Am. Nat. **31**: 339. 1897

Described from specimens collected by Ellis on decaying white oak limbs buried beneath decaying leaves at Newfield, New Jersey, in September and October, 1896. I find only one packet so labeled in the Ellis Collection and it is practically destroyed by insects. Its date is October 1, while the description was drawn from specimens (which I do not find) collected on the same host, October 17. Ellis says that the hymenium is more or less tinged with violet or lilac at first, changing mostly to dirty-white or yellowish-white on drying. I imagine that the affinities of the species are rather with some of the thin, white forms previously studied than with the present group.

72. PORIA CARYAE (Schw.) Cooke, Grevillea **14**: 111. 1886

This species was treated in Mycologia for March, 1920. The specimens mentioned there as Ellis & Ev. N. Am. Fungi *2306,* collected by Calkins in Florida, seem to be incorrectly determined and belong nearer to the *Poria vincta* group. Other good specimens found in the Ellis Herbarium are as follows:

Ohio, *Morgan 229.* This is probably a part of the same collection sent to Underwood in 1894, which has already been cited.

London, Canada, on beech, by *Dearness 1343,* December 6, 1889.

I have already referred to specimens collected by me on beech in northern Maine.

Kansas, *Cragin 193.*

73. PORIA CAVERNULOSA (Berk.) Cooke, Grevillea **14**: 113. 1886

Polyporus cavernulosus Berk. Jour. Bot. & Kew. Misc. **8**: 235. 1856.

Collected on dead branches at Panuré, Brazil, by Spruce and described as follows:

"Resupinate, orbicular, at length confluent, of a dirty fawn colour, darker in the centre, rigid; margin narrow, formed of matted down, but not byssoid; pores $\frac{1}{45}$ of an inch across, subhexagonal; edge rigid, sometimes elongated at the commissures, sometimes slightly waved."

Original specimens seen at Kew are not distinct from resupinate forms of *Trametes versatilis* Berk., although a totally different plant was found under this name at Paris and in the Fungi Cubenses Wrightiani. *P. byssoideus* Jungh. in the Persoon herbarium at Leiden also seemed to me the same as *T. versatilis*, while Romell says that *Poria Dusenii* P. Henn. belongs in the same category.

NEW YORK BOTANICAL GARDEN.

SMUTS AND RUSTS OF UTAH—IV[1]

A. O. Garrett

USTILAGINALES

6. Ustilago Bromivora (Tul.) Fisch. de Waldh.

In ovaries of *Bromus tectorum* L.: *2503*, June 2, 1919, Salt Lake City. Another collection on the same host was made in October, 1919. *2755*, August 20, 1920, Providence, Cache Co.

This smut was very abundant in the early summer of 1919 on this host on the "benches" around Salt Lake City. In 1920, it has been observed in equal abundance extending northward to the Idaho line. Previous to these collections, but one other collection was known for this host, Dr. Clinton informs me; and that was made by Dr. Hitchcock in Oregon.

9. Ustilago hypodytes (Schlecht.) Fries

On *Oryzopsis hymenoides* (Roem. & Schult.), Ricker (*Eriocoma cuspidata* Nutt.): *2514*, July 18, 1919, Price, Carbon Co.

On *Hilaria Jamesii* (Torr.) Benth.: *2508*, July 18, 1919, Price, Carbon Co. Host determined by Mrs. Agnes Chase; smut by Dr. Clinton, to whose herbarium a specimen has been contributed. This is the first collection of the smut on this host.

12. Ustilago Lorentziana Thüm.

In inflorescence of *Hordeum caespitosum* Scrib.: *2015c*, June 15, 1909, Salt Lake City.

In inflorescence of *Sitanion Hystrix* (Nutt.) J. G. Smith; *2592*, June 12, 1920, near East High School, Salt Lake City. Host determined by Dr. Hitchcock.

27. Ustilago Hieronymi Schröt.

In inflorescence of *Bouteloua curtipendula* (Michx.) Torr. (*B. racemosa* Lag.): A collection from Utah on this grass is listed in N. A. Flora 7[1]: 13. 1906.

29. Ustilago Tritici (Pers.) Rostr. Overs. K. Danske Vid. Selsk. Forh. 1890: 15. 1890

In spikelets of *Triticum vulgare* L.: *2583*, July 19, 1919, Castle Dale, Emery Co. *2692a*, July 18, 1920, Cedar City, Iron Co. *2510*, July 18, 1919, Price, Carbon Co.

[1] The previous papers of "Smuts and Rusts of Utah" were published in Mycologia as follows: I, 2: 265–304, Nov., 1910; II, 6: 240–258, Sept., 1914; III, 11, 202–215, July, 1919.

UREDINALES

6. PUCCINIA INTERVENIENS (Pk.) Bethel in Univ. Cal. Pub. **7**: 119. 1919

Aecidium roestelioides Ellis & Ever.
Puccinia Burnettii Griff.

The rust recorded under No. 101 of this list as *Puccinia Stipae* Arth. on *Stipa minor* (Vasey) Scrib. should be placed here. This collection was made Aug. 26, 1909, near Gogorza, Summit Co. Nearly defunct aecia on *Sidalcea nervata* (listed as No. 6 of the "Smuts and Rusts of Utah") were collected the same day in the immediate vicinity. Mrs. Clemens had made a collection of fine aecia in the same locality in May of the same year.

8. MELAMPSORA CONFLUENS (Pers.) Jackson, Brooklyn Bot. Gar. Mem. **1**: 210. 1918

Caeoma confluens (Pers.) Schöt.

On *Grossularia inermis* (Ryd.) Cov. & Britt.: *2594*, June 21, 1920, Gogorza, Summit Co. The gooseberry bushes were growing under the willow trees, and were very heavily infected. A single sorus was taken from the willows. *2621*, July 1, 1920, Henry Ranch, above Panguitch Lake, Garfield Co.

On *Grossularia leptantha* (A. Gray) Cov. & Britt.: *2622*, July 1, 1920, Henry Ranch, above Panguitch Lake, Garfield Co. Another collection on this host was made between Panguitch and Panguitch Lake.

On *Ribes petiolare* Dougl.: *2741*, O, I, August 16, 1920, above Silver Lake, Big Cottonwood Canyon. The material was too old when collected, but Dr. Arthur considers it to belong to this species of rust. The writer has previously collected the rust on *G. inermis* within a quarter of a mile from where this collection was made. Willows were within a few feet of the bushes of *R. petiolare* from which the collection was made.

On *Salix Watsonii* (Bebb) Rydb.: *2593*, II, June 21, 1920, Gogorza, Summit Co. A leaf with a few sori was taken from one willow. The gooseberries growing below were heavily infected with the Caeoma stage. *2637*, II, July 15, 1920, same locality as No. *2593*. The Caeoma on the gooseberries growing below the willows had all gone, leaving only scars on the leaves to show where it had been. *2772*, III, Sept. 12, 1920, East Canyon, Summit Co.

9. GYMNOSPORANGIUM NELSONI Arth.

On *Juniperus utahensis* (Engelm.) Lemmon: *2511*, July 18, 1919, Price, Carbon Co. *2607*, June 25, 1920, Manti, San Pete Co. *2627*, July 1, 1920, head Mammoth Creek above Panguitch Lake, Garfield Co. *2639*, July 17, 1920, Maple Canyon branch of Cedar Canyon, near Cedar City, Iron Co.

On *Juniperus scopulorum* Sarg.: *2298*, July 22, 1915, Logan Canyon, Cache Co. *2600*, June 23, 1920, McGee Canyon, near Santaquin, Utah Co. *2645a*, July 17, 1920, Maple Canyon branch Cedar Canyon, Iron Co. Some old cedar trees at the head of Coal Creek branch of Cedar Canyon had nearly every branch affected. *2698*, July 29, 1920, Parowan Main Canyon, near Parowan, Iron Co.

On *Amelanchier mormonica* C. K. Schneider: *2718*, Aug. 3, 1920, Beaver Canyon, near Beaver, Beaver Co. Host determined by Dr. Rydberg.

On *Amelanchier polycarpa* Greene: *2645*, I, July 17, 1920, Maple Canyon branch of Cedar Canyon, about five miles from Cedar City, Iron Co. The host was determined by Dr. Rydberg.

On *Amelanchier Jonesiana* C. K. Schneider?: *2661a*, I, July 19, 1920, Coal Creek branch, Cedar Canyon, about fifteen miles from Cedar City, Iron Co. The host is determined tentatively by Dr. Rydberg.

15. MELAMPSORELLA ELATINA (Albert & Schw.) Arth. I

Dr. Hedgcock, in his paper "Some Western Uredineae," states that the aecial stage of this rust (*Peridermium elatinum*) is conspicuous on *Abies lasiocarpa* (Hook.) Nutt, in the Manti National Forest.

17. PHRAGMIDIUM IVESIAE Sydow, II, III

Ph. affine Sydow.

On *Potentilla pulcherrima* Lehm.: *2759*, Aug. 20, 1920, Richmond, Cache Co. Host determined by Dr. Rydberg.

19. PHRAGMIDIUM HORKELIAE Garrett

On *Ivesia Gordonii* (Hook.) T. & G.: *2744*, Aug. 16, 1920, east slope from Twin Lakes, Big Cottonwood Canyon, Salt Lake Co.

21. PHRAGMIDIUM MONTIVAGUM Arth.

On *Rosa neomexicana* Cockerell: *2617*, June 28, 1920, Bullion Canyon, near Marysvale, Piute Co. *2759a*, Aug. 23, 1920, Mendon, Cache Co. *2774*, Sept. 18, 1920, Parley's Canyon, opposite refreshment stand.

On *Rosa puberulenta* Rydb.: *2651*, July 19, 1920, Coal Creek branch, Cedar Canyon, Iron Co. *2720*, August 3, 1920, Beaver Canyon, Beaver Co.

All of the above roses were determined by Dr. Rydberg.

25. PUCCINIA CLEMATIDIS (DC.) Lagerh.

On *Elymus condensatus* Presl.: *2512*, July 18, 1919, Price, Carbon Co. Determined by Dr. Arthur.

On *Poa Fendleriana* (Steud.) Vasey: *2673*, II, Wiley Camp, Zion National Park, Washington Co.

On *Ranunculus Cymbalaria* Pursh.: *2613a*, I, June 28, 1920, Marysvale, Piute Co.

On *Sitanion Hystrix* (Nutt.) J. G. Smith: *2710*, ii, Aug. 3, 1920, Beaver Canyon, near Beaver, Beaver Co.

On *Sitanion jubatum* Smith: *2671*, ii, July 22, 1920, Zion National Park, near Wiley Camp, Washington Co. The near-by *Clematis ligusticifolia* bore aecia.

32. PUCCINIA URTICAE (Schum.) Lagerh.

P. caricis (Schum.) Schröt.

On *Carex nebraskensis* Dewey: *2577*, Oct. 11, 1919, Riverton, Salt Lake Co.

55. PUCCINIA GRAMINIS Pers.

On *Elymus Macounii* Vasey: *2576*, Oct. 11, 1919, Riverton, Salt Lake Co. Host determined by Mrs. Agnes Chase; rust by Dr. Arthur.

On *Triticum vulgare* L.: *2719*, II, Aug. 3, 1920, Beaver, Beaver Co. Rust determined by Dr. Arthur.

59. PUCCINIA HELIANTHI Schw.

On *Helianthus annuus* A. Gray: *2675*, July 22, 1920, Zion's Canyon, Washington Co.

63. PUCCINIA HIERACII (Schum.) Mart.

On *Hieracium griseum* Rydb.: *2636*, July 15, 1920, Gogorza, Summit Co.

69. PUCCINIA JONESII Peck

On *Cogswellia* sp.: *2650*, July 17, 1920, Maple Canyon branch of Cedar Canyon, Iron Co. *2702*, July 29, 1920, Parowan Main Canyon, Iron Co. The host in both collections was too old for determination, but is not one of the species previously reported as a Utah host for *P. Jonesii*.

76. PUCCINIA MENTHAE Pers. II

On *Mentha spicata* L.: *2692*, July 28, 1920, Cedar City, Iron Co. *2756*, August 20, 1920, Providence, Cache Co. *2757*, August 20, 1920, Millville, Cache Co. Not before reported on this host for Utah.

79. PUCCINIA MONTANENSIS Ellis

On *Agropyron tenerum* Vasey: *2519*, II, July 22, 1919, Orangeville, Emery Co. Determined by Dr. Arthur.

On *Elymus canadensis* L.: *2517*, II, July 22, 1919, Orangeville, Emery Co. Determined by Dr. Arthur.

On *Hordeum jubatum* L.: *2518*, II, July 22, 1919, Orangeville, Emery Co. Determined by Dr. Arthur.

78. PUCCINIA MONARDELLAE Dudley & Thompson II

On *Madronella oblongifolia* Rydb.: *2707*, July 30, 1920, "Fish Lake Mtn.," Iron Co. Host determined by Dr. Rydberg; rust by Dr. Arthur.

85. PUCCINIA PATTERSONIANA Arth.

On *Agropyron spicatum* (Pursh) Scribn. & Smith: *2599*, II, III, June 21, 1920, Gogorza, Summit Co. The only suspicious aecia found in the vicinity were those included in this list as *Uromyces Brodieae*. Although some of the aecia were quite old, no telia nor uredinia could be found.

On *Elymus condensatus* Presl.: *2770*, II, III, Sept. 12, 1920, East Canyon, near Gogorza, Summit Co., not far from collections *2599*. This was a heavy infection. The aecial host of this rust has never been determined.

96. PUCCINIA SHERARDIANA Körn.

P. Malvastri Peck.

On *Sphaeralcea pedata* Torr.: *2680*, July 21, 1920, Zion's Canyon, Washington Co. Host determined by Dr. Rydberg.

On *Sphaeralcea arizonica* Heller: *2680a*, July 23, 1920, Hurricane, Washington Co. Host determined by Dr. Rydberg.

On *Sphaeralcea dissecta* (Nutt.) Rydb.: *2712*, Aug. 3, 1920, Beaver Canyon, Beaver Co. Host determined by Dr. Rydberg.

On *Sphaeralcea subrhomboidea* Rydb.: *2753*, August 19, 1920, Logan, Cache Co. Host determined by Dr. Rydberg.

105. PUCCINIA SUBNITENS Dietel

On *Heliotropium spatulatum* Rydb. I, collected by E. M. Hall May 17, 1919, at St. George, Washington Co.

On *Tropaeolum* sp. cult. I, collected by E. M. Hall May 22, 1919, at St. George, Washington Co. This is the first collection ever made on this host.

On *Beta vulgaris* L. I, collected by E. M. Hall May, 1919, at St. George, Washington Co.

On *Atriplex rosea* L. (*A. spatiosa* A. Nels.) I, collected by E. M. Hall May 18, 1919, at St. George, Washington Co. I, collected by Ellsworth Bethel May 27, 1919, at Salt Lake City.

On *Lepidium perfoliatum* L. I, collected by Ellsworth Bethel May 27, 1919, at Salt Lake City. This is the first collection reported on this host.

On *Chenopodium album* L. I, collected by Ellsworth Bethel May 27, 1919, at Salt Lake City.

107. PUCCINIA SUBSTERILIS Ellis & Ev. X, iii

On *Stipa Lettermanni* Vasey: *2687*, Coal Creek branch of Cedar Canyon, about fifteen miles from Cedar City, Iron Co. *2771*, Sept. 12, 1920, East Canyon, Summit Co.

On *Oryzopsis hymenoides* (Roem. & Schult.) Ricker: *2670*, July 22, 1920, Zion National Park, across river from Wiley Camp. The mesospores of this collection were in germinating condition.

114. PUCCINIA RUGOSA Billings, King's Report 40th Par. 914. 1871

P. Troximontis Pk.

On *Ptilocalais tenuifolia* Osterhout: *2596*, June 21, 1920, Gogorza, Summit Co.

129. UROMYCES PUNCTATUS Schröt.

On *Kentrophyta impensa* (Sheld.) Rydb.: *2647*, July 17, 1920, Maple Canyon branch of Cedar Canyon, Iron Co. Host determined by Dr. Rydberg.

On *Astragalus* sp.: *2659*, July 19, 1920, Coal Creek branch of Cedar Canyon, Iron Co. A small species of *Astragalus*, not previously included in this list.

On *Astragalus humistratus* A. Gray: *2660*, July 19, 1920, Cedar Canyon, Iron Co. Host determined by Dr. Rydberg.

On *Astragalus Sonorae* A. Gray: *2660a*, July 19, 1920, Cedar Canyon. Host determined by Dr. Rydberg.

131. UROMYCES INTRICATUS Cooke

Uromyces Eriogoni Ellis & Hark.

Two collections were made, each on a different species of *Eriogonum*, and each new to the species hitherto recorded in this list. Both hosts were too young, however, for specific determination. One collection was made in Maple Canyon, Iron Co., and the other in Zion Canyon, Washington Co.

132. UROMYCES PROEMINENS (DC.) Pass.

U. Euphorbiae Cooke & Peck.

On *Chamaesyce Greenei* (Millsp.) Rydb.: *2646a*, July 18, 1920, Cedar City, Iron Co. *2509*, July 18, 1919, Price, Carbon Co.

On *Chamaesyce rugulosa* (Engelm.) Rydb.: *2708*, Aug. 3, 1920, Beaver Canyon, Beaver Co. The host of each of these collections was determined by Dr. Rydberg.

148. COLEOSPORIUM RIBICOLA (C. & E.) Arth. II

On *Ribes cereum* Dougl.: *2638*, July 17, 1920, Maple Canyon, branch of Cedar Canyon, Iron Co. *2705*, July 30, 1920, First Left-hand Fork Parowan Canyon, Iron Co. *2716*, August 4, 1920, Beaver Canyon, Beaver Co. The host of these collections is considered to be the same as *R. inebrians* Lindl.

149. CRONARTIUM FILAMENTOSUM (Peck) Hedgc. & Long I

Peridermium filamentosum Peck.

On *Pinus ponderosa scopulorum* Engelm.: *2628*, July 1, 1920, extending southward from the south edge of Bryce Canyon, Garfield Co. This is the first record of the collection of this Peridermium in Utah. The Peridermium at this location is abundant, and is doing considerable damage to the pine trees.

150. CRONARTIUM PYRIFORME (Peck) Hedgc. & Long I

Peridermium pyriforme Peck.
Cronartium Comandrae Peck.

On *Pinus ponderosa scopulorum* Engelm. Collected by Vernon Christensen (a former student in botany at the East High School, Salt Lake City), July 15, 1920, headwaters Provo River, Wasatch Co. This is the first collection of this Peridermium in Utah, although the Cronartium has previously been reported from several localities.

152. GYMNOSPORANGIUM GRACILENS (Peck) Kern & Bethel I

On *Philadelphus occidentalis* A. Nelson: *2669*, July 22, 1920, Zion Canyon, Washington Co. Host determined by Dr. Rydberg. This extends the distribution of this Gymnosporangium about two hundred miles westward.

153. GYMNOSPORANGIUM INCONSPICUUM Kern

On *Juniperus utahensis* (Engelm.) Lemmon: *2641*, July 17, 1920, Maple Canyon branch of Cedar Canyon, about five miles from Cedar City, Iron Co. The entire tree was covered with brown smears at and near the tips of the branchlets. *2700*, July 29, 1920, Parowan Main Canyon, opposite Second Left-hand Fork. The branchlets covered with this rust (both in this collection, and No. 2641 above) seemed to be dead or dying.

On *Amelanchier utahensis* Koehne: *2643*, I, July 16, 1920, Maple Canyon branch Cedar Canyon, about five miles from Cedar City, Iron Co. The infection was so heavy on the Amelanchiers of the region that scarcely a fruit could be found not affected by the rust. *2674*, July 22, 1920, Zion National Park, near Wiley Camp, Washington Co. All of the fruits of all of the trees in the canyon seemed to be affected. *2704a*, July 30, 1920, First Left-hand could be found not affected by the rust. *2674*, July 22, 1920, Zion National Fork Parowan Canyon, near Parowan, Iron Co. *2725*, I, Aug. 7, 1920, Fillmore, Millard Co. The peridia are beautifully developed in this collection. Rust determined by Dr. Arthur.

On *Amelanchier prunifolia* Greene: *2669a*, I, July 22, 1920, Zion National Park, above Wiley Camp, Washington Co.

On *Amelanchier Jonesiana* C. K. Schneider: *2701*, I, July 29, 1920, Parowan Main Canyon, near Parowan, Iron Co. Host determined tentatively by Dr. Rydberg.

All of the above aecial forms are on the fruit.

The canyons of southwestern Utah are surely a paradise for the collector of the Gymnosperms. Indeed, they are present in such profusion, and on such a variety of hosts, as to offer a very considerable puzzle to the collector who attempts to keep the species separated.

154 MELAMPSORA ALBERTENSIS Arth. I

Caeoma occidentalis Arth.

On *Pseudotsuga mucronata* (Raf.) Sudw.: *2685*, July 27, 1920, Coal Creek Canyon branch of Cedar Canyon, about fourteen miles from Cedar City, Iron Co. This is the first recorded collection of this Caeoma for Utah, although the Melampsora on *Populus tremuloides* has been reported from San Juan Co.

164. PUCCINIA GRINDELIAE Peck

On *Chrysopsis horrida* Rydb.?: *2676*, July 22, 1920, Zion Canyon, Washington Co.

181. UROMYCES OBLONGUS Vize

Three collections of this rust were made: *2679*, July 22, 1920, Zion Canyon, Washington Co.; on *Trifolium Kingii* S. Wats.: *2686*, July 27, Coal Creek branch Cedar Canyon, Iron Co.; and *2706*, July 30, 1920, First Left-hand Fork Parowan Canyon, Iron Co. The rust was abundant; but with the exception of No. 2686 the Trifolium plants were too old to be determined.

184. AECIDIUM ALLENII Clinton

On *Shepherdia canadensis* Nutt.: *2686ab,* July 27, 1920, Coal Creek Canyon branch of Cedar Canyon, Iron Co.

187. CRONARTIUM OCCIDENTALE Hedgc., Bethel & Hunt

On *Pinus edulis* Engelm.: *2614a,* June 27, 1920, mouth of Bullion Canyon, near Marysvale, Piute Co. *2697,* July 29, 1920, Parowan Main Canyon, Iron Co. A number of infections were on the tree from which this collection was made.

On *Ribes aureum* Pursh: *2696,* July 29, 1920, Parowan Main Canyon, Iron Co. *2715,* Aug. 3, 1920, Beaver, Beaver Co. *2724,* Aug. 6, 1920, Hinckley, Millard Co. *2726,* Aug. 7, 1920, Fillmore, Millard Co. *2730,* Aug. 9, 1920, Holden, Millard Co. *2732,* August 9, 1920, Scipio, Millard Co. *2738,* August 13, 1920, Oak City, Millard Co. *2748,* Aug. 20, 1920, Lewiston, Cache Co. *2751,* Aug. 22, 1920, Hyrum, Cache Co. This was beautiful uredineal material. *2760,* Aug. 23, II, III, Mendon, Cache Co. *2763,* II, III, Aug. 24, 1920, Morgan, Morgan Co. The rust in III was also collected October 15, 1920, on bushes along Current Creek, in DuChesne County, a half-mile from the Wasatch County line by Miss Ruby Harkness, a former student in botany in the East High School, Salt Lake City. She reports that she found the Cronartium on the first bush examined.

On *Ribes cereum* Dougl.: *2714,* August 3, 1920, Beaver Canyon, just below Upper Telluride Plant, about twelve miles from Beaver, Beaver Co. (This host is not considered sufficiently distinct from *R. inebrians* to warrant their separation.)

On *Grossularia leptantha* (A. Gray) Cov. & Britt.: *2713,* Aug. 3, 1920, same locality as No. *2714* given immediately above. A small tree of *Pinus edulis* grew between the bushes. Not before reported for Utah on either of these last two hosts.

All of the above are new records for the distribution of the *Cronartium* and the *Peridermium.*

189. GYMNOSPORANGIUM JUVENESCENS Kern

On *Juniperus scopulorum* Sargent: *2642,* III, July 19, 1920, Cedar Canyon near Cedar City, Iron Co. *2698a,* July 29, 1920, Parowan Main Canyon near Parowan, Iron Co. *2640,* July 17, 1920, Maple Canyon branch Cedar Canyon, about five miles from Cedar City, Iron Co. *2699,* July 29, 1920, Parowan Main Canyon, near Parowan, Iron Co.

On *Amelanchier oreophila* A. Nels.: *2618,* I, June 28, 1920, Bullion Canyon, near Marysvale, Piute Co.

192. PERIDERMIUM COLORADENSE (Dietel) Arthur & Kern

On *Picea Engelmanni* (Parry) Engelm.: *2661,* July 9, 1920, Coal Creek branch Cedar Canyon, about fourteen miles from Cedar City. The aecia were just beginning to develop at this date. Many trees were affected.

203. UROMYCES FUSCATUS Arth.

On *Rumex paucifolius* Nutt.: *2636a*, July 15, 1920, Gogorza, Summit Co. There has been some doubt in regard to the true identity of the host of this rust, the original description giving it as *Polygonum alpinum*. Several collections were made at this date from the same locality from which the original Utah collection was made June 29, 1915. The host plants were in bloom and young seed, and one plant was collected in flower with the broad lower leaves strongly infected by the rust. Unfortunately, this specimen has been mislaid. Host determined by Dr. Rydberg.

206*.[2] GYMNOSPORANGIUM JUNIPERINUM (L.) Mart. Fl. Crypt. Erlang. 333. 1817

On *Juniperus siberica* Burgsd.: *2615*, June 28, 1920, Bullion Canyon, near Marysvale, Piute Co. This is the first collection of this rust reported from Utah

207*. PHRAGMIDIUM IMITANS Arthur, N. A. Flora 7: 165. 1912

On *Rubus strigosus* Mich.?: *2684*, July 27, 1920, Coal Creek branch Cedar Canyon, about fourteen miles from Cedar City, Iron Co. The host was submitted to Dr. Rydberg for determination, and he writes: "It is none of the Rocky Mountain forms of red raspberry, but may be an escape of the eastern *R. strigosus*."

208*. PUCCINIA APOCRYPTA Ellis & Tracy

On *Agropyron tenerum* Vasey: *2663*, II, III, July 19, 1920, Coal Creek branch Cedar Canyon, about fourteen miles from Cedar City, Iron Co. Host determined by Dr. Hitchcock; rust by Dr. Arthur.

209*. PUCCINIA ANTIRRHINI Diet. & Holw. Hedwigia **36**: 298. 1897

On leaves and stems of *Antirrhinum majus* L.: *2507*, July 12, 1919, Salt Lake City, Salt Lake Co. This destructive rust of greenhouse plants is altogether too widely spread in the greenhouses of Salt Lake and adjoining counties.

210*. PUCCINIA MICRANTHA D. Griff I. Bull. Torrey Club **29**: 299. 1902

On *Grossularia leptantha* (A. Gray) Cov. & Britt.: *2717*, Aug. 3, 1920, Beaver Canyon, just below Upper Telluride Plant, about fourteen miles from Beaver, Beaver Co. This collection moves the range of the species at least 200 miles westward.

211*. PUCCINIA SUAVOLENS (Pers.) Rostr. Forh. Skand. Nat. **11**: 339. 1874

On leaves of *Cirsium arvense* (L.) Scop.: *2506*, July 9, 1919, Provo, Utah Co. This collection extends the westerly range of this species by several hundred miles.

[2] Numbers followed with the asterisk (*) are those of species not included in any of the three preceding lists.

212*. UROMYCES BRODIEAE Ellis & Hark. I. Bull. Cal. Ac. Science **1884**: 28. 1884

On *Brodiaea Douglasii* S. Wats.: *2597*, June 21, 1920, Gogorza, Summit Co. The rust seemed to attack only the plants of the first year's growth. No plants in bloom could be found with the rust on them. No leaves with uredinea or telia could be found at this time, nor again on July 15. This leads to the suspicion that possibly we might have here the aecium of an unattached grass rust. As *P. Pattersoniana* occurred in abundance in the immediate vicinity, it was suspected of being the alternate form. This will at least bear investigation.

213*. UROMYCES MEDICAGINIS Pass. in Thüm. Herb. Myc. Oecon. 156. 1874

On leaves of *Medicago sativa* L.: *2766*, Sept. 4, 1920, Salt Lake City. Not hitherto reported from Utah. Schroeter (Krypt. Fl. Schl. 3^1: 306. 1887) and Trebaux (Ann. Myc. **10**: 74. 1912) state that in Europe this rust has its aecial stage on various species of *Euphorbia*. The aecial stage has not yet been recognized as occurring in America.

EAST HIGH SCHOOL,
SALT LAKE CITY, UTAH.

THE BEHAVIOR OF TELIA OF PUCCINIA GRAMINIS IN THE SOUTH

H. R. Rosen

Since July, 1918, the writer has had under observation the behavior of telia of *Puccinia graminis* Pers. on various grasses and the relationship of this spore stage to the overwintering and dissemination of the rust. It is well known that barberries, both native and introduced, are present in the southern states, and yet infections on this alternate host are apparently rare. Stakman (Separate from Yearbook of the United States Dept. of Agric. No. 796, 1918, p. 25) says, "There can be no question whatever that the barberry is the most important factor in the spread of rust in the northern half of the Mississippi basin. In the South it is less important." In a previous paper Rosen and Kirby (Phytopathology 9: 569–573. 1919, p. 571) record the absence in the Arthur Herbarium of aecial collections of *P. graminis* from the southern states. It was with the thought that a study of the behavior of telia might shed some light on the lack of barberry infections that these observations were undertaken at Fayetteville, Arkansas, latitude 36°. While the average temperatures prevailing at Fayetteville are lower than those in a major part of the state, the observations made in other sections indicate a close similarity in the behavior of stem rust.

As a rule black stem rust is not nearly as widespread or as destructive as the various leaf rusts. Occasionally, as in 1919, the wheat leaf rust, *Puccinia triticinia* Erikss., is so destructive that fields are abandoned and left unharvested, while the stem rust is only rarely observed. However, the stem rust of red top, *Agrostis palustris* Huds. (*A. alba* of authors) of timothy, *Phleum pratense* L., and of *Elymus australis* Scrib. and Ball is often prevalent. Perhaps it will be worth while to point out that the main difference between the urediniospores of the stem and leaf rusts is in the arrangement of the pores, being always equatorially disposed in the stem rust and always scattered in the leaf rusts. Such characters as color, shape, and size of the spores vary with

hosts, with degree of maturity and somewhat with environmental conditions. Racial differences are well known. The uredinia of stem rust have been studied, and dates kept of the earliest and latest appearance, but a discussion of this stage will be left for the future.

As compared to the uredinia, the telia of stem rust of the cereals are rare and underdeveloped in this state. At harvesting time, or indeed at any other time, while the uredinia may be readily found it usually takes careful searching to obtain telia. Moreover, examination of telia under the microscope shows spores which are considerably undersized and otherwise abnormal. In the fall of 1918, as well as in the fall of 1919, wheat straw containing telia, collected around Fayetteville, were put into wire cages and allowed to remain out of doors during the winter. No germination occurred, in contrast to the teliospores of over-wintered material of *Elymus australis* which germinated profusely as will be described. No explanation is at hand for this lack of normal telial development. It seems probable that the frequent and prolonged "dry spells" characteristic of the growing seasons of this section may have some influence on the development of telia. Possibly the time of wheat harvesting, usually in the first half of June, coming considerably earlier than in the sections where a profuse development of normal telia is common, as in the spring wheat section, may have something to do with it.

But while the cereal grasses ordinarily do not produce viable telial material the writer has carefully checked up the viability and infectivity of this stage on *Elymus australis*,[1] one of the common grasses of the region around Fayetteville. It is rather drought resistant, frequently to be seen making good growth when other grasses, both wild and cultivated, are either dead or suffering for want of moisture. During the fall of 1919 a very heavy infestation of the stem rust, in the form of telia, was noted in a good-sized patch of *Elymus* growing along a road side. The telia, unlike those observed on the cultivated cereals, appeared well developed, of a blackish color, and when examined under

[1] The writer is indebted to Mrs. Agnes Chase of the U. S. Department of Agriculture for the identification of this grass.

the microscope showed spores of a typically normal type in size, shape and color. The unique character of this telial material contrasting strongly with lack of telial development on other hosts and especially with material collected on the same day on timothy in which no telia but a very heavy infestation of uredinia was observed, made it appear worth while to study this *Elymus* infection. Several times during the fall, winter and early spring attempts were made to germinate the material collected on these different occasions but always without success. Profuse germination was finally obtained from material collected on April 5. This germinating material was smeared on young, moistened leaves of *Berberis trifoliolata* Moric., on a potted plant growing in the greenhouse, and the whole plant covered with a bell-jar for forty-eight hours. Another plant, uninoculated, served as a check. Reddish-yellow, cushion-like spots began to develop in about six days, and in eleven days, numerous pycnia, mostly epiphyllous, had developed. No infections developed on the check plant. The pycnia were typical of *Puccinia graminis* and the infections as a whole were similar to those obtained on the same host infected by using germinating telia on wheat straw coming from Iowa. (See Rosen and Kirby, loc. cit., p. 571.) It should be added that the telia were viable on April 29 and that on June 25 no germination was obtained. No data is at hand to indicate to which specialized race the telia of *Elymus australis* belong. Apparently this species of *Elymus* has not previously been recorded as a host for *P. graminis* and material has accordingly been deposited in the Arthur Herbarium. However, Stakman and Piemeisel (Jour. Agr. Res. **10**: 429–495. 1917) list various species of *Elymus* as congenial hosts for two specialized races which attack wheat, the "biologic forms" *tritici* and *tritici compacti,* for the one which attacks rye, *secale,* and for the oat race, *avenae,* which appears only slightly infectious on *Elymus* spp.

The telia on *E. australis* here recorded are of interest not only because they differ from the ordinary behavior of stem rust telia in this region, but because they clearly show that if telia are fully developed they can be "overwintered" properly in this region and that they are infectious.

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NOTES AND BRIEF ARTICLES

[*Unsigned notes are by the editor*]

Readers of MYCOLOGIA are invited to contribute to this department personal news items and notes or brief articles of interest to mycologists in general. Manuscript should be submitted before the middle of the month preceding the month in which this publication is issued.

A new method of isolating single spores in Petri dishes for transfer is described by Carl D. LaRue in the *Botanical Gazette* for October, 1920.

Volume 7, parts 4 and 5, of *North American Flora,* by J. C. Arthur appeared at the close of 1920. They include descriptions of 201 species of *Dicaeoma,* of the Aecidiaceae. This important genus of plant rusts comprises, according to Dr. Arthur, a total of 269 species.

The dry-rot of incense cedar is discussed by J. S. Boyce in Bulletin 871 of the U. S. Department of Agriculture. The attacks of *Polyporus amarus* are very severe, owing to forest fires and various mechanical injuries. Trees with sporophores or serious wounds should be promptly cut. The rotation for incense cedar, according to the author, must not exceed 165 years in the intermediate and 210 years in the optimum range.

In his excellent paper on Crown-gall of Alfalfa, published in the *Botanical Gazette* for July, 1920, Mr. O. T. Wilson suggests that, although Magnus was right in removing the causative parasite from the genus *Cladochytrium,* it is doubtful whether he was justified in placing it in *Urophlyctis.* The author concludes with some interesting remarks about the Chytridiaceae in general and their relationship to the Myxomycetes.

In a short paper on Porto Rican fungi in the *Botanical Gazette*

for November, 1920, F. L. Stevens describes *Linospora trichostigmae,* on *Trichostigma octandra*; *Trabutia portoricensis,* on *Cocolobis nivea*; the genus *Trabutiella,* with *T. cordiae* as its type; *Hyponectria phaseoli,* on *Vigna vexillata*; and *Zythia phaseoli,* on *Phaseolus.* A fuller description is also given of *Anthostomella rhizomorphae* (Ktz.) B. & V., collected on *Rhizophora mangle.*

A Crop Protection Institute has been organized under the National Research Council to bring together the scientist, the grower, and the business man for mutual consultation regarding problems connected with the growing and marketing of crops. It proposes to cooperate with existing organizations wherever possible, and to undertake work that has hitherto been overlooked or imperfectly done. The control is in the hands of a Board of Trustees, two thirds of whom are scientists.

An abundantly illustrated article on the early development of *Inocybe,* by Gertrude E. Douglas, appeared in the *Botanical Gazette* for September, 1920. The lamellae develop as in most of the gill-fungi except those of the *Amanita* type. No marginal veil is formed, but the ground tissue on the outside of the pileus fundament becomes the blematogen, or universal veil. Several species of *Inocybe* were used for this study, the fresh plants in various stages being fixed in chromo-acetic acid of medium strength, then imbedded in paraffin, and stained with fuchsin after treatment with tannic acid.

An important paper on the development of *Cyathus* and *Crucibulum,* by Lena B. Walker, appeared in the *Botanical Gazette* for July, 1920. Six plates, with 70 excellent figures, greatly enhance the value of this paper. The three species used, *C. fascicularis, C. striatus,* and *C. vulgare,* grew readily on artificial media, but only the first produced mature fruit-bodies. The peridioles originate in all three species at given centers, toward which the ends of filaments converge. The most marked difference between *Crucibulum* and *Cyathus* is in the structure of the walls of the

peridia. In *Cyathus* a middle layer is present which is entirely wanting in *Crucibulum.*

Bulletin of the New York State Museum, Nos. 219, 220, appeared in January, 1920. It contains a reprint of the report of the state botanist for 1886, which has been so difficult to secure because so few copies were originally printed. A paper on fungi by Dr. House includes descriptions of *Mycena filopes* (Bull.) Quél. and *Mycena Atkinsoni* House, and the following new combinations: *Lophiotrema Peckiana* (Sacc.) House, *Helminthosporium pedunculatum* (Peck) House, *Gloniopsis Gloniopsis* (Gerard) House, and *Stereum Willeyi* (Clinton) Burt.

The first number of the *Bulletin of the Yama Farms Mycological Club* appeared in September, 1920. It contains a description of Yama Farms; the origin and purposes of the Club; plans for the future; a list of books and papers on the larger fungi; and a list of officers, including John Burroughs, W. A. Murrill, H. D. House, C. F. Millspaugh, G. T. Moore, William Trelease, H. I. Miller, C. H. Kauffman, Howard A. Kelly, Robert T. Morris, and others. The Club intends to make Yama Farms, a vast virgin tract in the southern Catskills, an important mycological center, with facilities for collecting and studying the fungi and other interesting forms of plant and animal life. Mrs. O. B. Sarre is permanent secretary-treasurer, and she was assisted during the season of 1920 by Miss Grace O. Winter, a graduate of Pennsylvania State College.

Enzyme action in *Echinodontium tinctorium,* one of the most destructive heart-rotting fungi on conifers in the West, was briefly discussed by Henry Schmitz in the *Journal of General Physiology* for July 20, 1920. The culture of the fungus used in this study was obtained from a young sporophore by the tissue method. The sporophore was carefully washed with sterile distilled water, dried by means of sterile tissue towelling, and cut open. Small portions of tissue were taken from the interior of the fruiting body and transferred to potato agar slants. After

the fungus had made considerable growth, transfers were made from the agar slants to sliced sterile carrots in large Erlenmeyer flasks, and the cultures incubated for 3 months at a temperature of 32° C. The fungus makes comparatively slow growth both on hard potato agar and on the carrots. While still in an actively growing condition the fungous mats were removed from the flasks, and, when thoroughly dry, were finely ground. The following enzymes were found to be present in the fungus: Esterase, maltase, lactase, sucrase, raffinase, diastase, inulase, cellulase, hemicellulase, urease, rennet, and catalase.

A handsome paper on the mosaic disease of cucurbits by S. P. Doolittle, has appeared as Bulletin 879 of the U. S. Department of Agriculture. According to the author, this disease has apparently been present in the United States for nearly 20 years, but prior to 1914 its importance was practically unrecognized. It appears both in the field and in the greenhouse in nearly all sections where cucurbits are of commercial importance. Nearly all cultivated cucurbits are susceptible to it, but the cucumber crop seems to be most seriously affected, particularly in the Central States and the trucking regions of the South. The diseased plants develop a yellow mottling of the younger leaves, accompanied by a wrinkled or savoyed appearance. The older leaves gradually turn yellow and die, leaving the basal portion of the stem bare.

No visible causal orgainsm has been associated with cucurbit mosaic, and the disease appears to be unrelated to soil conditions. The juice of mosaic plants contains an infective principle, or virus, however,which possesses certain definite properties. The expressed juice of mosaic plants is rendered non-infectious if heated above 70° C. The power of infection is also destroyed by formaldehyde, phenol, and copper sulphate in 0.5 per cent solutions and by mercuric chlorid in a strength of 1:2,000. A 10 per cent solution of chloroform will also render the virus inactive, but neither 5 per cent chloroform nor 10 per cent toluene are effective.

The juice of mosaic diseased plants may be diluted to 1:10,000

and still retain the power of infection. The expressed juice of mosaic plants rarely remains infectious longer than 24 to 48 hours, and the virus is rapidly destroyed by desiccation. The infective principle, as far as it has been determined, possesses many properties of a living organism, and it appears possible that the disease may be caused by an ultramicroscopic parasite. The mosaic is highly infectious and can be produced by introducing the expressed juices or crushed tissues of a mosaic plant into slight wounds in healthy plants.

VOLUME 10 OF NORTH AMERICAN FLORA

The first three parts of this volume were issued some time ago. The manuscript for part 4, prepared by Kauffman and Overholts, will be ready for the printer within a few months. Part 5 will be chiefly devoted to *Cortinarius,* to be treated by Kauffman. Part 6 will continue the brown-spored and black-spored agarics; and part 7, the gasteromycetes and an index, concluding the volume.

Specimens of gill-fungi with brown or black spores, or any of the gasteromycetes, will be very gladly received from mycological friends. I do not care for *Poria* at present; this group will have to wait until volume 8, containing the Thelephoraceae, Clavariaceae, Hydnaceae, etc., is well started.

The determination of miscellaneous collections of the higher fungi must take second place with me henceforth, as my time for scientific work is limited. I have enjoyed this kind of work immensely during the past twenty years, and a vast number of interesting things have been added to the herbarium through collections sent in from widely separated localities.

If collectors wish to deposit sets of their larger fungi here without expecting reports until the various groups are worked, such specimens will be welcomed. In the case of special plants sent in for critical examination, please mention the species with which you would have them compared and also give microscopic characters, so as to facilitate comparison as much as possible.

W. A. MURRILL
Supervisor of Public Instruction

TWO SPECIES OF FUSCOPORIA

1. **Fuscoporia tenerrima** (Berk. & Rav.) comb. nov.

Polyporus tenerrimus Berk. & Rav.; Berk. Grevillea **1**: 65. 1872.
Poria tenerrima Cooke, Grevillea **14**: 115. 1886.

Described as below from Ravenel's Carolina collections on the bark of *Ulmus americana,* and known only from that region and on that particular host. It is rather difficult to decide where it belongs without seeing fresh, well-developed specimens, but its affinities appear to be with *Fuscoporia.*

"Entirely resupinate; very thin and tender, of a watery texture, tawny; pores very small, confluent, with very thin dissepiments."

Ellis, N. Am. Fungi *922*; Rav. Fungi Am. *710*; Rav. Fungi Car. **3**: *13*.

2. **Fuscoporia nebulosa** (Berk. & Curt.) comb. nov.

Polyporus nebulosus Berk. & Curt. Jour. Linn. Soc. **10**: 317. 1868.
Poria nebulosa Cooke, Grevillea **14**: 115. 1886.

Described as below from Wright's collections on dead wood in Cuba. Known only from one collection. The entire plant, including the tubes, is very thin and delicate. It apparently belongs in *Fuscoporia,* but I have not been able to examine it microscopically.

"Subiculo tenuissimo pulveraceo ferrugineo; hymenio fusco, poris parvis brevissimis angulatis, dissepimentis tenuibus rigidis integris."

W. A. MURRILL

A DOUBLE MUSHROOM

A peculiar specimen of the ordinary cultivated mushroom, *Agaricus campester,* was sent me last October from the Hupfel-Carrar Mushroom Plantation in the Bronx, with the following note:

"We are herewith sending you, under separate cover, a freak of nature in the form of a mushroom picked from our mushroom

cellars, which we thought would interest you. As you see, the stem grew right through the top of the same. This is the first occurrence we have had of this kind although we have picked hundreds of thousands of mushrooms since we started our cellar."

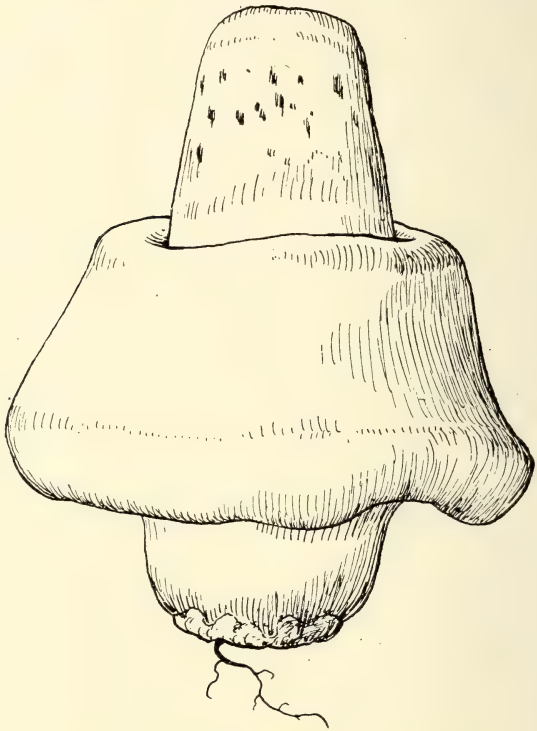

FIG. 1. Double mushroom, natural size

The accompanying sketches, reproduced natural size, was made by Miss Eaton from the fresh specimen. As may be seen in the section, there are two sets of gills, as well as two stems, as though the caps of two mushrooms occurring side by side had entirely grown together and the stronger mushroom had lifted the other into the air.

It is interesting to recall in this connection a figure, here reproduced, and a note that appeared in *Hardwicke's Science Gossip*, p. 209, 1866, which reads as follows:

"A TRIPLE MUSHROOM.—A physician of my acquaintance has a mushroom-bed in his cellar. A few weeks ago he *cut* one which was about five inches in

breadth, leaving the lower portion of the stem projecting from the bed. This afternoon he was surprised to find a peculiar double mushroom on the spot. It is formed of two mushrooms attached by their upper surfaces; the smaller one being placed in the inverted position on the upper one, and the cuticle of the two being continuous. The stem of the upper one was continuous with that of the large one which was cut off. The annexed sketch will give some idea of the nature of this curious monstrosity. The part above the dotted line represents the one cut off a few weeks ago; the part below is the double mushroom at present in my possession.—C. A."

While my attention was fixed on interesting morphological peculiarities like the above, a package of *Hypolysus Montagnei,* recently collected in Trinidad by Mrs. Britton, Miss Coker, and

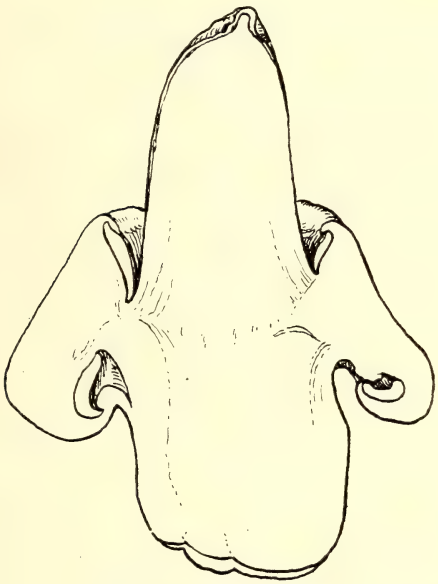

FIG. 2. Double mushroom in section, natural size

Mr. Rowland, was handed me for determination and I found that many of the small, goblet-shaped hymenophores had budded at the margin and produced from one to three secondary hymenophores with stalks and caps similar to the primary ones both in shape and size.

One frequently sees "buds" on the pilei of gill-fungi, usually bearing lamellae on their upper surface, but no trace of a stipe is ever present. In a pretty little specimen of *Marasmius* col-

lected last fall by Mr. George T. Hastings, a prominent "bud" had developed just at the apex of the pileus, looking as though the stipe had been prolonged and developed into a small, inverted, sessile pileus with lamellae similar to those of the normal

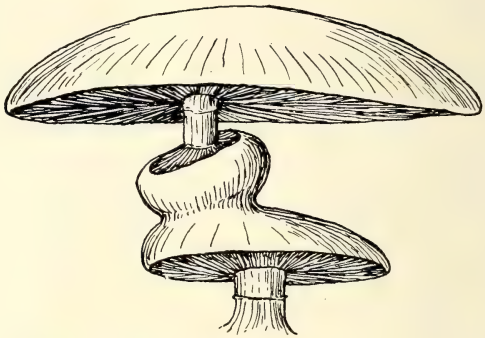

FIG. 3. Triple mushroom

pileus. The "buds," however, usually develop nearer the margin, those at the apex being very rare.

W. A. MURRILL

THE GENUS TINCTOPORIA

This genus was described in *North American Flora,* with *T. aurantiotingens* as its type. Two other interesting species belong here, one staining the substratum and the other not.

Hymenophore staining the substratum red.
- Hymenium black. 1. *T. albocincta.*
- Hymenium rosy-isabelline. 2. *T. graphica.*

Hymenophore not staining the substratum; hymenium black. 3. *T. Fuligo.*

1. **Tinctoporia albocincta** (Cooke & Massee) comb. nov.

Poria albocincta Cooke & Massee; Cooke, Grevillea **20**: 106. 1892.

Poria Fuligo aurantiotingens Ellis & Macbr. Bull. Lab. Nat. Hist. Univ. Iowa 3^2: 191. 1896.

Tinctoporia aurantiotingens (Ellis & Macbr.) Murrill, N. Am. Fl. **9**: 14. 1907.

This species was studied by me in 1907, but several collections

have come in since that time, and I have discovered at Kew that another specific name has priority over the one I then used. This is *Poria albocincta,* described as follows from specimens collected on bark on the Island of St. Vincent:

"Tota resupinata, atro-cinerea, demum fissurato fatiscens; margine lato, niveo, pulverulento, tenui; tubulis circa 1 mm. longis, poris minutissimis, inconspicuis. Sporis ellipticis, 4 x 2 μ."

The only host mentioned in the new collections is *Ilex lucida.* Additional collections are:

Mexico, *Murrill 224*; Porto Rico, *Earle 116, Stevenson & Johnston 1482*; Guadeloupe, *Duss 574, 906.*

2. **Tinctoporia graphica** (Bres.) comb. nov.

Poria graphica Bres. Hedwigia **35**: 282. 1896.

Collected on dead sticks in Brazil by Möller and described as below. A portion of the type is in the Garden herbarium.

"Late effusa tenuissima, lilacino-carnea, margine rubello, subiculo nullo; tubulis vix ¼ mm. longis; poris elongatis, sinuosis, variis, dissepimentibus tenuissimus praeditis; sporae non visae. Hyphae subhymeniales 3 μ latae."

3. **Tinctoporia Fuligo** (Berk. & Br.) comb. nov.

Polyporus Fuligo Berk. & Br. Jour. Linn. Soc. **14**: 53. 1875.
Polyporus Ravenalae Berk. & Br. Jour. Linn. Soc. **14**: 53. 1875.
Polyporus Büttneri P. Henn. Verh. Bot. Ver. Proc. Brand. **30**: 129. 1888.
Poria glauca Pat. Jour. de Bot. **5**: 312. 1891.

Originally described from Peradenya, Ceylon, and several times collected in the Orient. *P. glauca* was described from Tonkin and *P. Büttneri* from Cameroon, Africa. This species is thin, annual, black, with a glaucous bloom in young stages, and does not stain the substratum red.

W. A. MURRILL

NOTES ON A FEW PAPERS READ AT CHICAGO

Among the many interesting papers presented at the twelfth annual meeting of the American Phytopathological Society held

at Chicago, December 28–31, 1920, the following may be briefly mentioned:

"The regional occurrence of *Puccinia graminis* on barberry," by E. C. Stakman, R. S. Kirby, and A. F. Thiel.

The common barberry does not rust in the Southern States and on the Pacific Coast. It was found that barberries would not become infected in the Southern States when they were inoculated with teliospore material which had been developed in the South; but when inoculated with teliospores from the North, they became very heavily infected. Excellent infection was obtained as early as March 16 by using northern material. Teliospores from the South which had been kept in the North during the summer and fall, however, caused infection in the South, while northern teliospores which had been kept in the South did not cause infection. Teliospores formed in the fall in the South caused infection in the following spring. Evidently, therefore, the reason why barberries do not become infected in the South is not because conditions are unfavorable for infection, but because practically no teliospores are viable in the spring.

"The effect of incipient decay on the mechanical properties of airplane timber," by Reginald H. Colley.

Standard tests conducted at the University of California by the Bureau of Plant Industry in cooperation with the Forest Service indicate marked differences in the effect of different fungi on the mechanical properties of airplane timber. Pieces of Sitka spruce and Douglas fir showing incipient decay were tested against matched sound pieces. The effect of *Fomes pinicola, Fomes laricis,* and *Polyporus schweinitzii,* which may be grouped together, was decidedly more marked than that of *Trametes pini.* Test sticks taken many feet ahead of the typical rot showed the weakening effect of *P. schweinitzii,* while sticks infected with *T. pini* gave as high or higher results than sound wood. Lumbermen have long recognized that wood infected with *T. pini* is strong even in the early pocket stage. Results point to need for more careful inspection and diagnosis of incipient decay in forest and mill to prevent the expense of working and finishing defective stock and its inclusion in the airplane.

"Valsa poplar canker," by Alfred H. W. Povah.

This disease, under the name *Cytospora chrysosperma* (Pers.) Fr. has been reported from the Southwest by Long and from the Northwest by Hubert. It has been found near Syracuse, New York, to cause serious injury and in some cases death to *Populus tremuloides* and *P. grandidentata* when weakened by fire. Field studies show infection of 68.4 per cent and mortality of 36.9 per cent. The perfect stage (*Valsa* sp.) has been found on the trunks of infected trees. Inoculation experiments with pycnospores on cuttings of *P. tremuloides, P. grandidentata,* and *P. caroliniana* have resulted in the production of typical pycnia, bearing the characteristic red spore horns, and the death of the cuttings. Cuttings not inoculated but kept in the laboratory where material bearing spore horns was exposed soon became infected and were killed.

"Lightning injury to *Hevea brasiliensis*," by Carl D. La Rue.

Lightning injury to the Para rubber tree (*Hevea brasiliensis*) rarely manifests itself in tearing or breaking of the trunks or branches. Usually a single small branch at the top of the tree dies first. From this point the death of the branch continues downward until the trunk is reached, then the trunk dies back until the root is reached and finally the whole tree is killed. Several days may elapse from the time the injury is first visible until the whole tree is dead. The progressive death of the tissues is extremely suggestive of invasion of the tree by some destructive organism. The injury has been attributed to *Diplodia* and the supposedly guilty organism named *Diplodia rapax*. Cultures by the author showed *Diplodia* to be the only organism constantly present, but this is now known to be secondary and not the cause of the death of the tree. The injury is most pronounced in the cambium region. Here the tissue becomes deep-purple in color and decays with great rapidity, making it easy to trace the progress of the injury. The purple coloration is regarded by the author as diagnostic for this type of injury. Frequently, trees surrounding the dying tree show injury in lesser degree, which develops later than of the tree most seriously injured, thus suggesting the spread of an organism from one tree to the other.

"A dry rot of the sugar beet caused by *Corticium vagum*," by B. L. Richards.

A serious and apparently undescribed rot of the sugar beet has been observed during the past season in a number of beet fields in northern Utah and southern Idaho. The disease, as it appears in the field, is confined to somewhat definitely delimited areas wherein every beet may become infected. The roots of the diseased beets show circular lesions characterized by very prominent alternating light and dark brown concentric rings. The disease is typically a dry rot. In the later stages a deep pocket, partly filled with a dry pulp composed of mycelium and decayed host tissue, results at each point of infection. With numerous points of attack the beet by harvest time may be converted into a dry, pithy mass. Numerous isolations from sugar beets, taken from a number of fields, have given what, from cooperative studies, appears to be a single strain of *Corticium vagum* B. & C. Inoculation shows this strain to be extremely virulent, and lesions have been produced on normal healthy beets with unusual uniformity.

W. A. MURRILL

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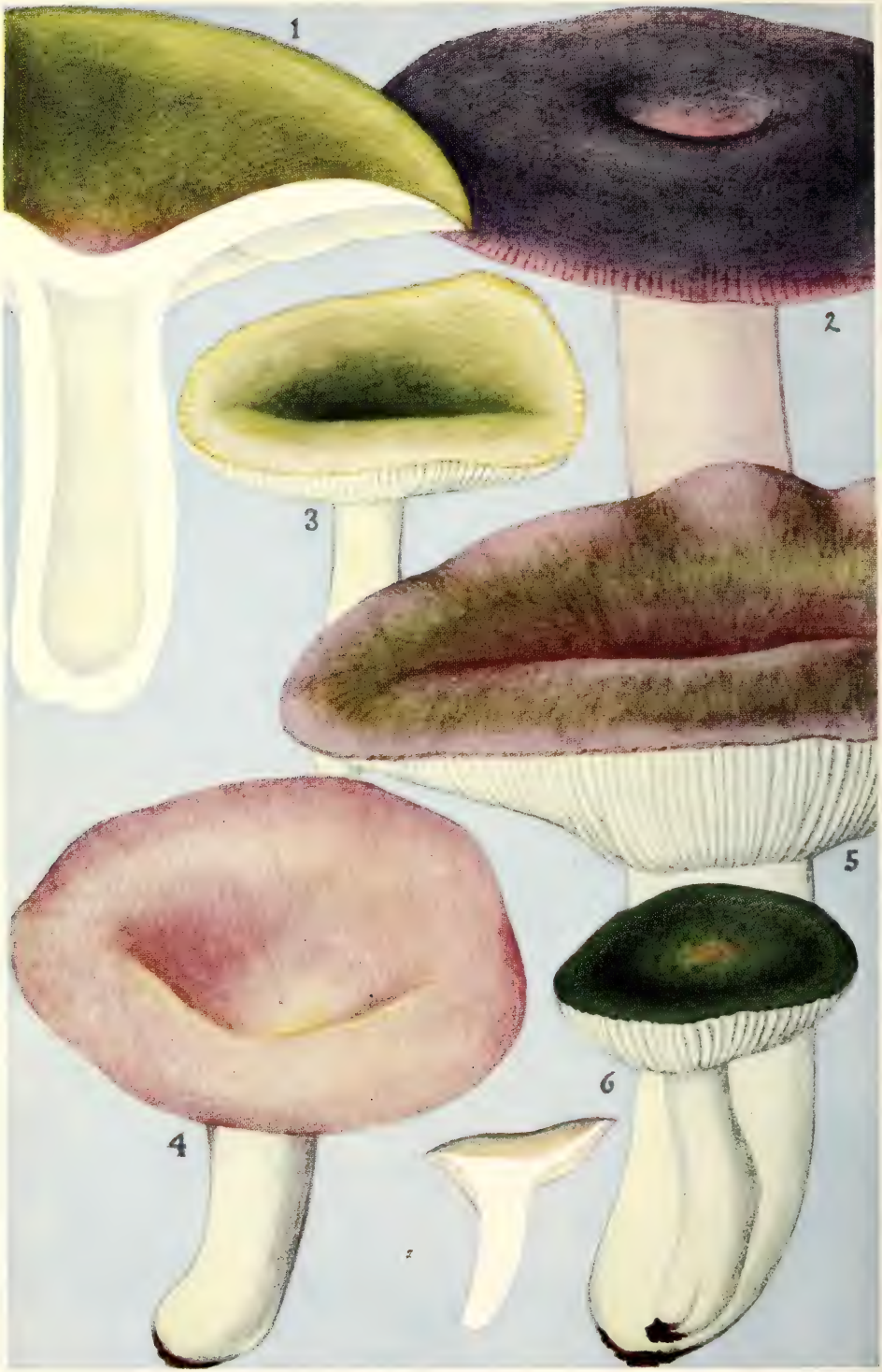


NEW SPECIES OF RUSSULA

MYCOLOGIA

VOL. XIII MAY, 1921 No 3

SOME NEW SPECIES OF RUSSULA

GERTRUDE S. BURLINGHAM

(WITH PLATE 7 AND 1 TEXT-FIGURE)

Most of the following species have been under observation for several years, and with the possible exception of *R. simulans* and *R. ornaticeps* they seem to be rare. Even these species are limited in season and in habitat. The first collection of *R. Hibbardae* was made in 1916 by Miss Ann Hibbard who also collected the type of *R. viridi-oculata.* She has made numerous water-color sketches of the species described from Vermont and has placed these at the disposal of Miss Eaton for the preparation of the plate which accompanies this article.

On July 29, 1919, I found several specimens of *R. disparilis* Burl. growing on Newfane Hill, Vermont, under yellow and white birches and poplars. This had previously been reported only from the type locality, Stow, Mass. The taste at first was sweet and nutty, then tardily peppery. The stipe in some specimens had a pink wash near the apex and base on one side. The lamellae in mature specimens were pale maize-yellow.

Russula simulans sp. nov.

Pileus fleshy, broadly convex, becoming infundibuliform with age, up to 11 cm. broad; surface reseda-green to ivy-green, paler on the margin, vinous-purple in the center, or slate-violet and green streaked together, or the whole faded with some yellowish spots, viscid when wet, cuticle separable half way to the center, striate-reticulate under the lens and very slightly so to the naked eye, glabrous; margin even or scarcely striate-tuberculate for a depth of about one mm., inrolled nearly to maturity; context

[MYCOLOGIA for March (13: 67–128) was issued March 26, 1921]

white, firm, soon slightly peppery, without special odor; lamellae white, heterophyllous, some forking part way to the margin or near the stipe, narrowed at each end, slightly decurrent, about 5 mm. wide at the center, close; stipe white, firm, spongy-stuffed, nearly equal, 5.5–7 cm. × 2–2.2 cm., sometimes pruinose at the apex; spores pure-white, ellipsoid, minutely echinulate with blunt, short projections, 6.25–6.87 × 8.75–9.37 μ.

TYPE LOCALITY: Newfane Hill, Vermont, 1,600 ft. elevation.

HABITAT: In woods usually under maple, birch, or oak trees, July and the early part of August.

DISTRIBUTION: Newfane Hill, Vermont, and Magnetewan, Ontario, Canada.

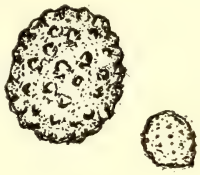
This species resembles *R. variata, R. heterophylla,* and *R. bifida* in certain respects. It differs from *R. variata* in its heterophyllous lamellae which seldom fork more than once. *R. variata* has a few short lamellae irregularly placed and the lamellae fork from two to three times. From *R. bifida* it differs in its acrid taste, less forking and thinner lamellae, and in the vinous shades on the pileus. From *R. heterophylla* it differs in its acrid taste. This is probably widely distributed and because of its close resemblance in the color of the pileus to that of *R. variata,* or in its green form to *R. heterophylla* has been referred to one or the other of the species.

Russula ornaticeps sp. nov.

Pileus convex-umbilicate, expanding when mature, with margin drooping, at length somewhat infundibuliform in old age, up to 10 cm. broad; surface variegated in color, Parma-violet, lilac-mauve and bluish-violet intermingled with grayish-violet, the lilac-mauve being usually in the center, surrounded by the indigo with bluish-violet on the margin, covered with a pruinose bloom, viscid when wet, the pellicle separable half way to the center; margin even, when young, somewhat striate-tuberculate when mature; context white, except next the cuticle, where it is tinged with the surface color, mild then slowly slightly acrid in and next the cuticle; lamellae fleshy-white, sometimes becoming rusty spotted near the edge, equal, some forking near the stipe, venose-connected, narrowed at the inner end, rounded at the outer, close; stipe white, occasionally washed with a faint tinge of violet, sometimes pruinose at the apex, irregularly striate, nearly equal

to abruptly narrowed at the base, 5–7 × 1.5–2 cm.; spores fleshy-white (t. 4), broadly ellipsoid, appearing minutely echinulate

1.



2.

3.

4.

5.

6.

FIG. 1. *R. viridi-oculata*
FIG. 2. *R. simulans*
FIG. 3. *R. Hibbardae*
FIG. 4. *R. ornatipes*
FIG. 5. *R. praeumbonata*
FIG. 6. *R. redolens*

under the 1/6 objective and reticulate under the oil immersion, 6.25 × 7.5 μ.

TYPE LOCALITY: Newfane Hill, Vermont, 1,600 ft. elevation.

HABITAT: In rather dry mixed woods in dead leaves, almost invariably under hop hornbeam trees, July, 1,300 to 1,600 ft. elevation.

DISTRIBUTION: Newfane, Vermont, and Magnetewan, Ontario, Canada.

This species has been found for four years from July 8 to August 4. It may occur earlier but I have rarely found it later. It is most abundant before the last week in July. It is very beau-

tiful when growing, but rather difficult to find on acount of its color. The peppery taste seems to be confined to the cuticle or the context adjacent, and becomes perceptible after thorough chewing. In color this resembles *R. cyanoxantha* but differs in the slight peppery taste, the equal lamellae, and the absence of cystidia. From *R. heterophylla* it differs also in the color of the spores. The beauty is lost in drying.

Russula viridi-oculata sp. nov.

Pileus fleshy, thin, soon plane, from 2.3–6 cm. broad; surface dark dull-green (264—t. 4) or darker blue-green in the center, shading to dull sage-green (278—t. 1) on the margin, fading with age to greenish-white (15—t. 1) toward the margin, viscid when moist, cuticle separable, slightly pruinose when young; margin even, recurved at first, extended when mature; context white; unchanging, peppery, slightly pungent, with the odor of green apples when fresh; lamellae white, equal, a few forking next the stipe, rounded and free, broad throughout, powdered somewhat with spores; stipe white, spongy, glabrous, equal, 5 cm. × 1–1.2 cm.; spores white, broadly ellipsoid, uniguttulate, apiculate, minutely echinulate.

TYPE LOCALITY: Newfane Hill, Vermont, 1,500 ft. elevation.

HABITAT: Under a group of pines in mixed woods, July 28, 1919.

This may be distinguished from *R. aeruginea* by the promptly acrid taste. It differs from *R. redolens* in taste as well as in odor and color and in the spore markings. It is smaller than *R. variata* and differs in the lamellae forking only near the stipe. It is also a small delicate mushroom more like *R. fragiliformis* in size and texture.

Russula Hibbardae sp. nov.

Pileus fleshy, broadly convex, then plane to depressed, up to 10.5 cm. broad; surface vinous-purple to slate-violet on a background of Naples-yellow, unevenly colored, sometimes yellow with only a wash of slate-violet in places, pruinose-velvety, viscid when wet, but soon dry, cuticle separable nearly half way to the center; margin even or slightly striate-tuberculate on extreme edge; context white, unchanging, slowly becoming slightly peppery, without special odor; lamellae nearly white, then maize-

yellow (t. 1–2), a few reaching only half way to the stipe, forking near the stipe or a short distance away, interveined, rounded, and only slightly attached next stipe, rounded at outer end, close, broad; stipe white, unchanging, pruinose at apex, spreading a little next stipe, otherwise equal, firm, then spongy, 3–7 cm. × 1.5–2.3; spores maize-yellow (t. 2–4), apiculate, symmetrical, echinulate, with spiny ridges forming reticulations, 6.2 × 7.5–8 μ.

TYPE LOCALITY: Newfane Hill, Vermont.

HABITAT: In dead leaves under beeches, August.

DISTRIBUTION: Found in two different localities on Newfane Hill.

This species seems rare and very distinct. The peppery taste develops slowly and seems to be chiefly in the cuticle. I have found the species each summer since 1916 and although I have searched for it during July for three years I have not seen it until toward the end of the first week in August. As a rule the vinous color is more prominent toward the center of the pileus.

Russula redolens sp. nov.

Pileus convex, then plane, depressed in the center, up to 4.5 cm. broad; surface dark drab-green to greenish-gray, sometimes paler toward the center, viscid when wet, appearing dull and pruinose when dry, cuticle separable; margin nearly even; context white, taste strong and disagreeable, becoming slightly peppery, odor when dried like strong celery, persisting; lamellae pure-white, equal, some forking near the stipe, midway to the margin, or near the margin, venose-connected, narrow at the inner end, broadest in the center, rounded at the outer end; stipe white, tapering toward the base, spongy, becoming hollow, glabrous, 2 cm. × 1 cm. at apex, much narrower at the base; spores pure-white, very minutely echinulate, 5–7.5 × 5.6–7.5 μ.

TYPE LOCALITY: Newfane Hill, Vermont, 1,600 ft. elevation.

HABITAT: Under maple, oak and spruce, or beech trees, August 3 and 11.

DISTRIBUTION: Newfane Hill and South Londonderry, Vermont.

This can be distinguished from all other green species of *Russula* by the strong celery-like taste and odor, which becomes noticeable in drying. The odor of the type collected in August, 1916, still persists in 1920.

Russula praeumbonata sp. nov.

Pileus fleshy, conical then expanding, with a large umbo, up to 5.5 cm. broad, surface scarlet-red to Nopal-red or ox-blood red on the umbo, glabrous, viscid when wet, with cuticle separable half way to the center; margin becoming widely striate-tuberculate; context white, unchanging, brittle, without special odor, mild in taste; lamellae white, equal, simple, finely serrulate, venose-connected, adnate; stipe white, tapering upwards, very brittle and fragile, stuffed, becoming hollow, up to 10 cm. long by 1 cm. thick; spores pure-white, broadly ellipsoid, very echinulate, apiculate, 6.2–8.75 × 8.75–10 μ.

TYPE LOCALITY: Stow, Massachusetts, Simon Davis.

HABITAT: In a swamp under deciduous and coniferous trees, September.

DISTRIBUTION: Stow, Massachusetts, Newfane, Vermont, and Magnetewan, Ontario, Canada.

This is related to *R. purpurina* and *R. uncialis*, but differs from both in the presence of an umbo, in the more distant lamellae, the absence of red on the stipe, and the larger, more ellipsoid and more echinulate spores. From *R. purpurina* it differs further in that the lamellae remain nearly white even in drying, while in *R. purpurina* they become decidedly yellow. Three collections were made from the type locality in 1917 and one in 1918.

Late in August, 1919, I collected in Newfane, Vermont, two specimens of apparently the same species. The taste of these seemed to be at length slightly bitter as did the specimen found at Magnetewan.

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EXPLANATION OF PLATE 7

Fig. 1, 5. *Russula simulans.*
Fig. 2. *Russula ornaticeps.*
Fig. 3. *Russula viridi-oculata.*
Fig. 4. *Russula Hibbardae.*
Fig. 6. *Russula redolens.*

THE LIFE HISTORY AND IDENTITY OF "PATELLINA FRAGARIAE," "LEPTOTHYRIUM MACROTHECIUM," AND "PEZIZA OENOTHERAE"

C. L. Shear and B. O. Dodge

(With Plates 8–10 and 5 Text-figures)

During our studies of the causes of decay and spoilage of small fruits in picking, shipping and marketing a number of fungi have been found which have been only recently or not heretofore reported on fruit. The pathological and economic aspects of these organisms will be treated in a separate paper. We would direct attention here to only one point of distinct pathological significance brought out by this study and that is the importance of a full knowledge of the life history, identity, and synonymy of pathogenic fungi. The conidial form of the organism under consideration here was recently recognized as the cause of disease and decay in strawberries in this country, referred to the form genus *Patellina* and described as a new species, *P. fragariae* Stevens and Peterson (1916). Obviously, if this pathogen were really an undescribed species new to this country and restricted to the strawberry, its pathological and economic aspects would be quite different from those of an old and widely distributed organism known to occur on a variety of hosts in three forms, not only in this country, but in Europe and South America, as now proves to be the case.

The present paper treats of the life history, morphology and taxonomy of this particular fungus which has been found frequently by the writers on strawberries and other small fruits and is now shown to occur on a great variety of plants and plant parts. Besides the new information brought out in connection with the interesting life history, morphology and host relations of this organism, there are other facts strikingly illustrated by

the list of synonyms given. Though this list is probably incomplete it shows that the fungus has not only been described under various generic names but that the conidial form has been referred to such widely separated genera as *Dacryomyces,* among the Basidiomycetes and *Sphaeronema* and *Tubercularia* among the Imperfecti. This is an excellent example of the confusion which prevails in the present nomenclature and taxonomy of the ascomycetes. This deplorable condition must be remedied before much permanent progress can be made in systematic mycology.

It has been found that three distinct types of fructification are developed in the life cycle of this fungus. The oldest name which we have yet proved to belong to the first or conidial stage is *Hainesia lythri* (Desm.) v. Höhnel (see *pl. 8*). The second or pycnidial stage, will be referred to as *Sclerotiopsis concava* (Desm.) (see *pl. 9*), and the third or ascogenous stage as *Pezizella lythri* (Desm.) (see *pl. 10, figs. 19–22*).

The first record we have of the conidial form of the fungus in our laboratory is by the late Dr. W. Ralph Jones who secured cultures from *Rubus* in May, 1912, which were referred tentatively to *Patellina.* The fungus was next found on decaying strawberries sent by Mr. G. M. Darrow of the Bureau of Plant Industry from Tennessee. It produced shallow cup-shaped, pinkish-yellow bodies and was doubtfully referred to the genus *Excipula.* In 1915 specimens of decaying strawberries bearing the same fungus were received from Hammond, Louisiana. Several other collections were also received from the same locality the same season. This conidial stage on strawberry was described and figured by F. L. Stevens and A. Peterson (1916) as *Patellina fragariae* n. sp.

During the spring of 1918 the writers found the rot caused by this fungus to be very common on strawberries in the markets of New York City and Washington and a thorough study of the organism was undertaken. The same year what appeared to be the same fungus was found frequently on rotting dewberries at Hamlet, Cameron and other points in North Carolina and at Hammonton, New Jersey. It has also been found on red and black raspberries in the New York markets and is not uncommon

on blackberries in New Jersey. A few sporodochia of the same fungus were found in April, 1920, on old dewberry vines from Cameron, North Carolina, and cultures were readily obtained from this material, showing that the fungus had survived the winter on the old vines.

The material from North Carolina was also found to bear conspicuous brown or black sclerotium-like pycnidia which proved to be *Leptothyrium macrothecium* Fckl. This was reported by Fuckel to occur on a variety of hosts, one of which was *Rubus*. On account of the close association of the *Hainesia* sporodochia and the *Leptothyrium* pycnidia and the great similarity of the spores of the two forms a possible genetic relation was suspected. If this was true the *Leptothyrium* stage, being evidently of a more persistent and resistant character than the other, might be the means of carrying the fungus over the winter. It may be noted here that cultures from these pycnospores produced typical conidial sporodochia. The pycnidial stage was also produced at will on leaves and stems of *Rubus* and other plants by spraying with a suspension of conidia.

Assuming that this fungus had but two lower spore forms it now remained to find the ascogenous stage. If any similarity in form was to be expected between the pycnidium and the ascocarp, *Hypoderma* might perhaps be suggested on account of its slight superficial resemblance to the pycnidia and its occurrence on some of the dewberry canes. On the other hand the sporodochia suggest in form a possible small discomycete of similar appearance. The discovery a little later of a small amber-colored discomycete on old leaves of raspberry at Arlington Farm, Virginia, July 24, closely associated with both sporodochia and pycnidia was immediately followed by pure cultures from ascospores which proved the genetic relation of the three forms. A search of literature and herbaria showed that a discomycete apparently agreeing in all respects with the one found on raspberry leaves, had been described as *Peziza* (Mollisia) *oenotherae* C. & E. (1878) and distributed as No. 846, Ellis and Everhart, N. A. F. and 244 Fun. Col. All three forms were found occurring together on stems of *Oenothera biennis* on the same herbarium specimen of No. 244

in the New York Botanical Graden and several other herbaria. The conidial stage was named *Sphaeronema corneum* C. & E. (1878) and distributed as No. 2074, E. & E., N. A. F. and the pycnidial stage was distributed as *Leptothyrium protuberans* Sacc. No. 733, E. & E., N. A. F.

CULTURES AND INOCULATIONS

The small, curved, hyaline spores of both conidial and pycnidial stages are produced abundantly and are easily recognized. As they germinate readily on all ordinary nutrient media, it is not difficult to obtain pure cultures by the poured plate method. On two per cent cornmeal agar the young colonies show a white mycelium, the branches of which unite in fascicles projecting above the surface of the agar. The sporodochia appear on poured plates about the third day and in test tube cultures about the fifth or sixth day. In both tubes and petri dishes they are frequently arranged concentrically. In old cultures on potato agar the sporodochia become brownish or almost black. On four per cent potato dextrose agar there is much greater aërial growth of mycelium and very small white sporodochia are formed in the water of guttation while those below on the agar are brown, especially when old.

Cultures of the conidial stage were obtained from strawberries in the market and inoculation experiments were carried out to determine whether the rot could be readily produced by artificial inoculations. As it is impracticable to thoroughly sterilize the surface of berries, clean, fresh fruit was chosen, the berries set on the calyx end in damp chambers and inoculated at the tip. A drop of water containing conidia was simply placed on the end of the berry or the epidermis punctured with a needle, or rubbed lightly. The controls sometimes developed sporodochia, especially those which had been punctured. The sporodochia originate subcuticularly or intraepidermally. Berries that are inoculated by puncturing will always develop sporodochia unless *Rhizopus* appears at once and prevents. The results of a large number of experiments show that only a slight injury to the epidermis is necessary to bring about infection but we have no proof

that the germ tubes are able to penetrate the uninjured, normal cuticle of the strawberry.

As the skin of many berries is usually injured and insects probably carry spores from berry to berry, it is frequently only necessary to provide moisture to insure development of sporodochia. It was found to be much more satisfactory to carry on this work with blackberries and dewberries as individual carpels could be carefully inspected before inoculation. The same experiments were carried out on these berries with strains of the fungus found on the berries in nature. The fungus spreads to carpels adjoining the one inoculated but slowly. Over-ripening brings about a softening or breaking of the cuticle so that such carpels become infected following surface inoculation. Berries in boxes were sprayed with a suspension of conidia, shipped from North Carolina to New York City and then placed in damp chambers. They developed large numbers of sporodochia. Boxes of berries similarly treated except that hulls were left on in picking, arrived in excellent condition and very few sporodochia could be found even after the berries had been left several days in damp chambers. The injury to the fruit caused by pulling off the hull apparently provides opportunity for the entrance of the fungus as berries picked with the hulls on are certainly not so susceptible to this and other fruit rot fungi which are not able to penetrate the unbroken cuticular layer.

It is also a question whether this fungus is able to penetrate the cuticle and epidermis of a normal living leaf. It is likely in most cases where sporodochia are found on living leaves that some injury has occurred to the epidermis. There is frequently evidence of insect injury in such cases. Under favorable conditions the fungus having gained entrance to the tissue appears to be able to spread to the adjoining tissue so that the spots become larger and quite characteristic as noted by Halsted (1893) on *Rhus* and Massalongo (1908) on leaves of *Rubus,* also by Stevens and Peterson (1916) on fruit of strawberry. The pycnidial stage is seldom found on living leaves but Massalongo noted that it sometimes occurs on spots on *Rubus* leaves. Both stages occurred very abundantly here during August and September,

1920, on decaying leaves of host plants cut earlier in the season. On such old leaves sporodochia are apt to be overlooked because of their very minute size. In some cases none is present though the pycnidia are very abundant.

There appear to be no morphological differences between the strains of the conidial form found in nature on fruits of species of *Fragaria* and *Rubus*. Many cross-inoculation experiments from one to the other have shown conclusively that the fungus can be readily transferred from the fruit of one of these hosts to the other.

Strains from dead spots on living leaves of *Fragaria, Rubus, Oenothera, Acer, Epilobium, Cornus, Smilax,* five species of *Rhus* and dead leaves of *Vitis,* and from the fruits of *Fragaria* and several species of *Rubus* show practically identical characters in culture.

The pycnidium is frequently one millimeter in diameter and as the wall is thick and composed of thick-walled cells it can be easily handled and thoroughly sterilized before being crushed out to obtain spores for cultures. When plated out and grown on the ordinary culture media sporodochia in no way distinguishable from those of *Hainesia* appear on the surface of the medium in three or four days. Such cultures have been isolated many times from the dark, heavy-walled pycnidial form on dewberry, strawberry, sumac, evening primrose, and other hosts and there can be no question of their being the pycnidial form of the same fungus that first appears as sporodochia of the *Hainesia* type.

The various agar media upon which the fungus has been grown do not appear to be favorable for the development of the pycnidia although they are occasionally produced in agar. The fungus grows well on the cut surface of apples and produces sporodochia, some of which resemble a broadly ostiolate pycnidium (*pl. 8, fig. 6*).

Strains of the *Hainesia* form isolated from a number of different hosts were grown on sterilized stems and leaves of blackberry in large test tubes. These cultures produced vast numbers of sporodochia within a week or two and then began to produce large, brown pycnidia of the *Sclerotiopsis* type.

So far as observed none of the cultures carried through under sterile conditions in petri dishes or test tubes has produced the perfect (*Pezizella*) stage. However, inoculation of wild blackberry leaves and stems under natural conditions in the woods produced all three forms. On May 20, 1920, living leaves and stems were punctured, then sprayed with a spore suspension of a strain of *Hainesia* originally obtained from dewberry. The tissue soon began to die about the points of inoculation and by the middle of June sporodochia were very plentiful on the spots. As the leaves died during July and August typical pycnidia and discocarps of *Pezizella oenotherae* began to appear in abundance on the dead leaves, petioles, fruit stalks and small branches. The perfect and pycnidial stage continued to develop slowly down to the larger branches and stems during September. While it is not claimed that the perfect stage might not have arisen from natural infections in this case, the experiment shows that it develops on leaves and branches of the season's growth and that it is unnecessary for the vines to lie over winter in order that, as is supposed with many ascomycetes, the ascocarps may mature in the spring and spread new infection. The ascospores of this *Pezizella* are set free or dispersed as soon as mature and germinate readily. The problem of over-wintering seems to have been provided for to a large extent by the thick-walled closed pycnidium. It is certain that many of these pycnidia pass through the winter unopened although filled with spores which will readily germinate in April.

Leaves petioles and runners of cultivated strawberry in a garden were inoculated in the manner described above with similar strains of *Hainesia,* May 20. Brown spots formed about the injured places and sporodochia began to appear within three weeks. By July 25 both sporodochia and pycnidia were abundant on the dead leaves of these and other plants in the same plot. No ascocarps of *Pezizella* were found.

Several leaflets of *Rhus glabra* were treated in the same manner August 5. On August 20 it was noted that many inoculated leaflets on this plant showed dead areas with typical amber-colored sporodochia. Leaf hoppers had by this time injured

many leaves on this plant and infection had spread naturally also. As the leaves died and fell to the ground they began to develop pycnidia. The perfect stage has not yet been found on *Rhus*.

Sclerotiopsis pelargonii Scalia has been reported on *Pelargonium* leaves. As it was impossible to obtain a specimen of this species to compare with the pycnidial stage of *Pezizella* which according to the description it appears to resemble closely, several leaves of rose geranium (*Pelargonium capitatum*) were inoculated by puncturing and spraying with conidia obtained originally from a single ascus culture from *Pezizella oenotherae*. The plant was kept under a bell-jar for four days and well aired and sprayed with water. Blackish streaks soon began to spread along the veins of several of the leaves where punctured. On September 11 sporodochia of *Haniesia* appeared and on September 14 most of the infected leaves bore typical pycnidia of *Sclerotiopsis*. A comparison of these pycnidia with *Sclerotiopsis pelargoni* Scalia will be made later. Scalia drew his description from specimens which developed on leaves kept in a damp chamber and does not mention finding any other form of fungus on the leaves.

On September 5, Dr. Neil E. Stevens found at North Livermore, Maine, on living leaves of *Epilobium spicatum* spots bearing sporodochia of *Pezizella*. Cultures made from this form differed in no way from those from other hosts. The leaves bearing conidia were placed in damp chambers from September 9 to 14 when they showed an abundance of the pycnidial form of the fungus. If leaves of any one of the host species upon which sporodochia are found are placed in a damp chamber for a week or two and kept fairly moist, pycnidia usually develop.

A hill of dewberries at Cameron, N. C., sprayed with conidia from dewberry, May, 1919, showed no signs of sporodochia on leaves or stems during the next two weeks, although berries picked from this hill developed many sporodochia. These vines were cut in July, kept in a warm, dry laboratory until April, 1920, and then placed on the ground in the woods. On July 25 they were examined. The leaves, fruit stalks and many of the

small branches bore an abundance of discocarps of *Pezizella oenotherae* and also typical pycnidia and sporodochia of the same. During the latter part of August pycnidia began to appear on the larger stems and in September these pycnidia could be found even at the base of the vines. It is not unlikely that the fungus winters over in this condition as many unruptured pycnidia can be found on vines collected in the field in April, too early for them to have developed during the spring. Spores taken form these overwintered pycnidia germinated readily.

It is rather difficult to obtain large quantities of ascospores of *Pezizella oenotherae*. Noting that spores still within the ascus germinated readily, apothecia were crushed in water and the young asci separated so that when small drops were placed on the surface of agar media the spread of the water was sufficient to separate the asci, care being taken to secure the proper dilution. By marking a number of spots on the petri dishes the separate asci could be located after germination had begun. The ascospores are so nearly the size of the conidia that they might otherwise be easily confused. In order to avoid this, only asci with germinating spores clearly distinguishable were transferred. Several dozen single ascus cultures were made at this time and in all about two hundred pure cultures in plates and tubes were obtained from asci. Without exception all produced sporodochia agreeing with *Hainesia*. Twenty-five single ascus cultures were made from two apothecia on raspberry leaves from Arlington Farm, Virginia, July 23, and 110 tube cultures from ascospores on the dewberry vines first sprayed with conidia at Cameron, N. C., May 26, 1919, and kept on the ground in the woods at Radnor, Virginia, from April 15 to July 26, 1920. The culture work here summarized proves conclusively the genetic connection between the three forms of fruit bodies described.

MORPHOLOGY

The morphological features of the *Hainesia* stage of this fungus have been fairly well described by the authors of the various specific names which have been applied to it. Stevens and Peterson (1916) have noted the variation in form, color and size of

the conidial fructifications as they appear on rotting strawberries and figured some of the essential features. Saccardo (1881) figures conidia and branched conidiophores.

I. CONIDIAL STAGE, HAINESIA LYTHRI (Desm.) v. Höhn.

By some writers these conidial fructifications are called pycnidia, by others acervuli and by still others sporodochia. There is great need of a thorough comparative study of the development and morphology of the various forms before a terminology can be applied which will indicate the true nature and relationships of different sporocarps that occur. Such studies made in connection with the life histories of the organisms should prove very helpful in determining the phylogeny and classification of the ascomycetes. For the purposes of this paper the conidial fructification of this fungus will be called a sporodochium. The fructification of *Hainesia* is a small disc-shaped body with a distinct excipulum-like base similar to that found in the apothecium of many discomycetes. It seems to the writers that this stage might well be placed among the excipulaceous fungi in the system of Saccardo. Considering only the variations of this one stage it will be shown that the fruit body assumes a variety of forms, some of which might be considered sporodochia of the *Tubercularia* type, while others approach true pycnidia with more or less clearly defined, broad ostioles.

In size the structures vary from a few conidiophores united in a fascicle with a minute globule of spores at the top, to a disc-shaped body 1 mm. in diameter which is readily visible to the unaided eye. The color may be brown, white, black, pink, yellow, amber, or golden depending upon the host or medium upon which the fungus is growing, the age of the culture, or other conditions of environment. The most common color when dry is some shade of amber. When wet they appear white from the mass of hyaline spores that gathers in a droplet of water and covers the disc. Though ordinarily disc-shaped or patellate the sporodochia may be elongate and slender or even cylindrical. Such forms when dried and capped with a pointed mass of spores were mistaken by Cooke and Ellis for a *Sphaeronema* and described as

S. corneum (1878). When the spores of the flat types spread out so that the spore masses coalesce a *Hymenula* is suggested, as *Hymenula rhoina* (1893) (Ell. & Sacc.), Bub. & Kab. (1912), or a *Tubercularia* as interpreted by Halsted (1893) (*T. rhoina* Halsted). Ordinarily nothing which might be called a stipe is present, yet forms are met in nature and in cultures on twigs of *Rubus* in which there is a distinct stipe-like base surmounted by a flaring disk (*pl. 8, fig. 7*).

The outer wall of the sporocarp is but a few cells thick. These cells are thin-walled and nearly isodiametric. Toward the margin the cells are arranged in more or less parallel rows and become considerably elongated and branched. Very long, branched slender paraphyses-like hyphae line the cup portion and extend even beyond the margin, sometimes producing a fimbriated edge (*pl. 8, fig. 10*). These structures appear in no way to differ from the conidiophores in their morphology, as they are found among the sporophores in young fruit bodies. The spores are borne terminally and become quickly detached, but cohere in a mass which becomes elongated and cone-shaped in case the spores are not washed away or there is not enough moisture present to lead to the formation of the trembling drop on the sporodochium which no doubt suggested the name *Gloeosporium tremellinum* to Saccardo. In nature very small sporodochia may develop on old, dead plant parts and in culture they form in the water of guttation where there is an abundance of aërial mycelium formed. These fruiting bodies, consisting of a few conidiophores united together, are clearly gymnocarpous and of the *Tubercularia* type, being open from the very beginning. They scarcely resemble the large patellate, urceolate or flack-shaped structures commonly collected (*pl. 8, figs. 1–4*). The amount of margin or the depth of the cup may become so great as to form a globose or pear-shaped structure which in no way differs from a true pycnidium with a large ostiole through which the spores ooze in a broad cirrhus (*pl. 8, figs. 6, 9*). In normal forms in nature most of the dark color is confined to the basal portion. The margin is at first inrolled (*pl. 8, fig. 5*), later becoming expanded and frequently revolute and lobed (*pl. 8, fig. 2*).

The conidia borne on simple or sparsely branched sporophores (*text-fig. 1*) are hyaline or only very slightly colored as seen under the microscope. In mass, however, the color is as variable as that of the sporodochium—white, pink, yellow, amber, brown, or blackish, depending upon the nature of the host, medium, moisture, age or other conditions. The usual color when dry is a

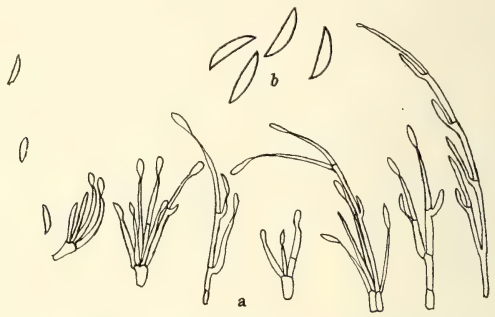

FIG. 1. a. Various types of sporophores of *Hainesia lythri*. × 700. b. Spores more highly magnified. × 1200.

light amber. The terms lunate, allantoid, curved and navicular have been used to describe their shape. Stevens & Peterson (1916) say they are straight or slightly convex on one side and concave on the other. Massalongo (1889) calls the pycnospores, which are the same shape as the conidia, navicular, and his drawings (l.c., *pl. 10, figs. 19–21*) suggest a boat or canoe viewed from the side as it floats on the water. Others describe them as straight with the ends sharply and obliquely angled. None has mentioned the small oil droplet frequently attached to one or both of the sharply pointed ends.

The conidia are remarkably uniform in size and shape. The average size is about 6–9 × 1.5–2 μ. Saccardo's record (1881) of 10–12 μ long for the spores of *Gloeosporium? rhoinum* is evidently an error judging from the magnification indicated and also from the spore measurements of *Hainesia rhoina* (Sacc.) Ell. & Sacc., No. 2278, E. & E., N. A. F., the spores of which are 7–8 × 1.5–2 μ.

II. PYCNIDIAL STAGE, SCLEROTIOPSIS CONCAVA (Desm.) n. comb.

The pycnidial form has been most frequently referred to *Leptothyrium macrothecium* Fckl. A study of the type of the genus *L. lunariae* Kze., however, shows that this species is not congeneric with it. In further search for a generic name it was found that the genus *Sclerotiopsis* of Spegazzini was based on the same species as ours. His type *S. australasica* proves indistinguishable from *Leptothyrium macrothecium*. *Sclerotiopsis* is the oldest unquestionable generic name we have found for the pycnidial form. The pycnidium is a large, closed, shield-shaped or depressed, pulvinate body which is packed with an enormous number of spores. Like the sporodochial stage this fruit body arises intra-epidermally so that as growth continues the cuticle together with the upper wall of the epidermal cells is stretched and pushed up until a shield-shaped or pulvinate body is formed, entirely covered by the upper part of the epidermal layer. On dewberry canes the epidermis may split at the center or in a line along the center. On leaves and large stems these pycnidia are nearly circular in outline often collapsing at the center on drying. This is the condition which suggested the specific name "*concava*" to Desmazieres.

The color varies with the age of the pycnidium, being at first gray to argillaceous, then light brown. Mature specimens are shining chestnut brown or almost black. These changes of color are well shown on leaves of *Epilobium*. As carbonization of the cell walls progresses the color approaches more nearly chestnut brown. On a substratum such as the blackberry cane the pycnidium is very smooth and shining, a feature not noticeable where the epidermis, such as that of a young *Oenothera* or *Quercus* leaf, is rough or covered with fine hairs. The pycnidium, being intra-epidermal, is long covered by the cuticle and cuticularized layer of the epidermis (*pl. 9, fig. 17*). The outer wall of the pycnidium is composed of small polyhedral thick-walled brown cells, the outer ones being somewhat flattened and brick-shaped. The inner ones have much thinner walls and are more angular, forming a rather broken or jagged border line. The basal or lower wall is made up of at least three distinct tissues. The first lying next to

the host cells below is composed of small thin-walled cells. Above this is to be found a dark layer composed of rather larger, polyhedral cells. This becomes thinner toward the margin which would appear to offer a favorable place for the pycnidium to rupture, but so far as observed marginal dehiscence does not occur. Above the middle layer lies that from which the conidiophores originate. It is composed of small, thin-walled, colorless cells (*pl. 9, fig. 16*).

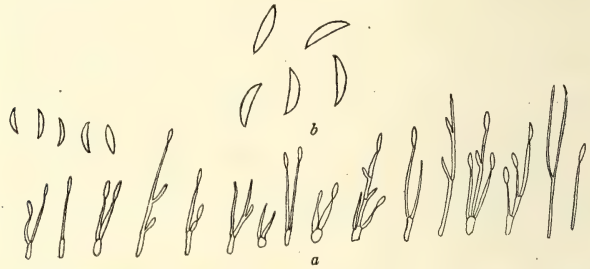

FIG. 2. a. Sporophores of *Sclerotiopsis concava.* × 700. b. Spores more highly magnified. × 1200.

In mature pycnidia the sporophores form a palisade-like layer covering the base of the pycnidium. They are 10–20 × 1 μ, frequently with short lateral branches (*text-fig. 2*). The spores are hyaline or faintly chlorine colored 6–9 × 1.5–2 μ. In old ruptured pycnidia the spores in mass may approach olivaceous. They are borne apically on the terminal and lateral branches, sometimes slightly adhering in chains as noted by Massalongo; but not ordinarily found in that condition as the spores usually separate as fast as they mature. They are boat-shaped, curved, acute, oblique-angled, convex on one side, slightly concave on the other. In keel view they are fusoid.

No ostiole is formed and the dehiscence of the pycnidium is often delayed until spring. It may occur, however, within a few weeks after maturity if the weather is very moist. The rupture of the epidermis should not be confused with the splitting of the wall of the pycnidium. In oblong forms on small branches, the rupture may extend in a single line from end to end (*pl. 9, figs. 14, 15*). In the circular types there are usually three or four cracks extending from the center toward the margin. The an-

gular segments thus formed (*text-fig. 3*) turn up or fold over exposing the spores which are quickly dispersed when wet, as they are surrounded by a mucilaginous substance which swells very quickly on addition of water and causes the spores to be pushed out and spread just as they are from the sporodochia.

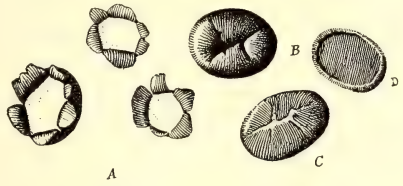

Fig. 3. Pycnidia of *Sclerotiopsis concava*. a. Three pycnidia showing characteristic dehiscence. b. Pycnidium after having discharged all of its spores and dried. c. A pycnidium just previous to spore discharge. d. Pycnidium after spore discharge and the breaking away of the segments of the wall.

III. Ascogenous Stage, Pezizella lythri (Desm.) n. comb.

The ascogenous stage has been found from the latter part of July to October. So far as known at present the discocarps were first described by Cooke & Ellis (1878). Ellis collected the specimens on *Oenothera* in August. They occur frequently associated with the other stages on dead leaves, petioles, fruit stalks and small branches of *Rubus,* and are especially abundant on the "bark" at the base of stems of living *Oenothera* and on the midrib and petioles of *Steironema*. They are most easily seen in the morning when the dew is on or after a rain when all the plant parts are wet. The disc then appears white, about ½–1 mm. in diameter and flat. The sides and short stalk-like basal portion are light-brown or amber colored. When dry they may retain the flat disc-shape, or the margin may become somewhat involute. In the latter condition they closely resemble the amber colored, hard resin-like dried sporodochia which are frequently found side by side with the discocarps. The pycnidia are not uncommonly found on the same specimens with the other two forms. Ellis evidently sometimes mistook the large dried sporodochia for the *Pezizella* stage on stems of *Oenothera* which he distributed as No. 846, N. A. F. On the specimens of this number in the herbarium of the U. S. Department of Agriculture there

are several large amber colored sporodochia of *Hainesia* and not a single ascocarp of the *Pezizella*. The white appearance of the apothecia when moist is due mostly to the presence of a mucilaginous substance including large quantities of small globules. Addition of water produces a sort of emulsion which spreads in a white layer over the flat disc. This epithecial substance may occur as the result of the disorganization of the upper ends of the paraphyses which in young ascocarps extend somewhat above the ends of the asci. The photograph (*pl. 10, figs. 19, 21*) shows some of this substance that persisted through the imbedding and sectioning processes.

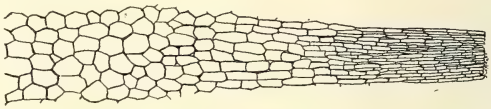

FIG. 4. Semi-diagrammatic view of a portion of the margin of the discocarps.

The stipe-like basal portion and the side walls of the apothecium are composed of a pseudoparenchymatous (plectenchymatous) tissue of light brown cells. At the margin the cells elongate forming a border of narrow cells arranged side by side (*text-fig. 4*). In view of this peculiar border or margin it is very likely that the apothecium is not "at first closed," strictly speaking, but from the appearance of the young fruit bodies as they break through the upper wall and cuticle of the epidermis they would commonly be said to be "closed at first then opening irregularly." Whether the apothecium has a true stalk may be questioned. Sections show the base to be variable, in some cases at least stalk-like (*pl. 10, fig. 22*), and at others simply tapering downward and funnel-shaped. Perhaps the shape of the apothecia of those species placed by Boudier (1910) in the genus *Micropodia* best represents the condition found here.

The asci are cylindrical, about $55–70 \times 7–8\,\mu$ (*text-fig. 5*). The apex is not colored blue by iodine. Sections show that the ascus is truncate at the apex and would probably be called marginate by Boudier, although this does not show at all in specimens crushed out on a slide.

The ascospores are straight or slightly curved, occasionally

somewhat enlarged at one end, $8 \times 2\,\mu$, uniseriate when young becoming biseriate when mature especially toward the apex (*pl. 10, fig. 21*). Spore dispersal is certainly not by "puffing" and air currents. The walls of the asci appear to deliquesce rapidly and it may be that insects and water are the chief agencies for the distribution of the ascospores. The paraphyses are narrow

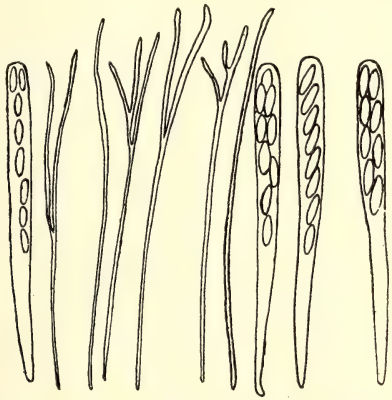

FIG. 5. Asci and paraphyses. *Pezizella lythri*. × 920.

linear 60–70 × 1–1½ μ, simple or branched, at first extending above the level of fully developed asci. The tips spread out and disorganize, giving rise to the "epithecium" which is composed in part of the mucilaginous products of this disorganization (*pl. 10, fig. 21*).

A comparison of the fruit forms of this species of fungus shows that the sporodochia and discocarps are so similar in their texture, size, color and general appearance as to be easily confused when dry. Even in this condition, however, they can be distinguished with a fair degree of certainty with a good lens as the mass of conidia usually forms a heap giving a pulvinate or conical shape to the top of the sporodochium; whereas the discocarp does not retain such a spore mass and is nearly plane or somewhat concave. They are readily distinguished in wet weather or when a drop of water is put on the surface of the fruit body. Under such conditions the conidia collect in a large droplet which maintains its form in whatever position the sporodochium be placed. Such a drop never collects on the surface

of the discocarp when wet. All three forms of fruit bodies ordinarily arise intra-epidermally. With the growth of the apothecium the basal portion may extend downward so that the lower portions of the epidermis become surrounded by cells of the fungus and are lifted up as the point of attachment elongates (*pl. 10, fig. 22*). The intra-epidermal habit is apparently quite fixed even when the leaf is covered with hairs. Sections through pycnidia on leaves of *Pelargonium* show that while the coarse, pointed hairs as well as the short, glandular hairs are raised so as to stand out like bristles on the wall of the pycnidium, yet the fungus is found to have invaded the lumen of the lower part of the hairs to a remarkable extent.

SYNONYMY

In view of the occurrence of three distinct types of fructifications in the life history of the fungus under discussion and considering that one or all of these forms may be found on a large number of host plants, either living or dead, some of which are distantly related; it is likely that the synonymy given here is not complete. This synonymy is based primarily upon a careful study of type or authentic specimens of most of the species discussed and on an abundance of fresh and herbarium material from various localities and hosts. A few probable synonyms based upon comparison of original descriptions only have been given. These are indicated in the list.

I. CONIDIAL STAGE, HAINESIA LYTHRI (Desm.) v. Höhn.

DACRYOMYCES LYTHRI Desm. The oldest name we have positively identified as belonging to any stage of this fungus is *Dacryomyces lythri* Desm. In 1846 Desmazières described this species on the label accompanying No. 1545 of his Pl. Crypt. France Ser. I. A careful study of the fungus distributed under this number from three sets, two in the herbarium of the Department of Agriculture and one in the New York Botanical Garden herbarium, shows that it is identical with the conidial stage of the *Pezizella* described here. Von Höhnel (1906 and 1918) had already pointed out that Desmazières' plant is a true *Hainesia*. It may

seem remarkable that this form should have been referred to *Dacryomyces,* which is now well understood to be a genus of Basidiomycetes. It must be remembered, however, that at the time this species was described, careful microscopic studies of these organisms had not been made and the reference to this genus was probably based upon the slight superficial resemblance which large sporodochia of this fungus have to the fructifications of certain small species of *Dacryomyces.*

SPHAERONEMA CORNEUM C. & E. The next description of the conidial stage which we have positively identified is under the name *Sphaeronema corneum* C. & E. (1878). The original description is brief and one would scarcely think from reading it that it applied to our fungus. It was said to have "cylindrical perithecia." A study of authentic specimens on stems of *Oenothera,* however, issued by Ellis & Everhart in N. A. F. No. 2074, shows that there is no fungus on these specimens, either the one in the herbarium of the Department of Agriculture or in the New York Botanical Garden habarium, agreeing with the usual generic characters attributed to *Sphaeronema.* There are, however, small sporodochia of *Hainesia* present with typical spores of this form. There is also found with the specimen of *Peziza oenotherae* E. & E., N. A. F. No. 846, a note on the label stating that this species is accompanied by *Sphaeronema corneum,* E. & E. on the same specimens. Here we also find well developed sporodochia of *Hainesia* but no trace of a true *Sphaeronema.* It seems certain, therefore, that the fungus to which Cooke & Ellis applied the name *Sphaeronema corneum* is none other than the conidial stage of *Pezizella lythri* and its reference to *Sphaeronema* was evidently due to the superficial resemblance of the sporodochia to the pycnidia of *Sphaeronema;* as has been already referred to in describing the morphology of this stage (p. 144).

GLEOESPORIUM ? TREMELLINUM Sacc. This was found on leaves of *Acer campestris* in Europe and first described by Saccardo (1880). The long branched sporophores lead him to insert the question as to its belonging to *Gloeosporium.* Later (1884) he referred it to *Hainesia* as *H. tremellina.* His figures (1881) and his description agree so well with the conidial form

of *Pezizella lythri,* as found on *Acer* in America, that there can be little doubt of its identity. We have, however, seen no authentic specimens of Saccardo's species.

GLOEOSPORIUM? RHOINUM Sacc. This species found on leaves of *Rhus glabra* in Italy and figured by Saccardo in 1881, was later (1882) described by him. Still later (1884) this was made the type of a new genus *Hainesia* by Ellis and Saccardo. Specimens collected by Ellis on *Rhus* in New Jersey are also cited by Ellis & Saccardo in the description of the species. The spore measurements given with the original figures and descriptions are 10–12 × 3 μ. This may be an error. There is a possibility, however, that Saccardo had another species of *Hainesia* with larger spores, as we suspect that one of this character does occur on *Rhus,* from the fact that there is on *Rhus cotinus* a *Sclerotiopsis* having larger spores, which has been described as *Leptothyrium rhois* West. by Fuckel (1870) but is not Westendorp's species. Saccardo has proposed the name *Gloeosporium rhois β fuckelii* for Fuckel's plant. This, according to Fuckel's specimen, which we have examined, is a true *Sclerotiopsis* closely related to *S. concava.* The conidia in Ellis' specimens on *Rhus copallina* in his herbarium and *Rhus aromatica* in N. A. F. No. 2278 are only 6–8 × 1.5–2μ. Von Höhnel (1918) also found the spores from European specimens on *Rhus* to 7–9 × 1.6–1.8 μ. Except for the measurements given, the figure and description of *Gloeosporium*? (*Hainesia*) *rhoinum* Sacc. agree perfectly with *Hainesia rhoina* Ellis & Sacc. Authentic specimens in Ellis' herbarium show that this is the same conidial form that is commonly found on several species of *Rhus* and other hosts in this country. In a later paper (1918) von Höhnel states that *Hymenula rhoina* (Ellis & Sacc.) Kab. & Bub. on *Rhus cotinus* is identical with specimens of *Hainesia rhoina* on *Rhus glabra* from Italy and North America. Von Höhnel finds the spores in Kabat's specimens Fun. Imp. 749, to be 7–9 × 1.6–8 μ and not as given by Saccardo (1882) and by Bubák and Kabát (1912). The latter authors state that the spores are 6–10 × 2.5–4 μ but in a later paragraph in the same paper the measurements are given as 6–16 × 2.5–4 μ. It appears clear that this is a typographical error, the "6" in "16" being used by mistake instead of "0."

Tubercularia rhois Halsted. This species collected by F. L. Stevens on *Rhus radicans* at New Brunswick, N. J., and issued and described in Seymour & Earle, Economic Fungi No. 273, May, 1893, is the same fungus that was later described by Stevens & Peterson as *Patellina fragariae* on fruit of cultivated strawberry and is identical with *Hainesia lythri* (Desm.) v. Höhn.

Hainesia epilobii Eliasson. We have seen no specimens of this species but the description (1897) agrees with *Hainesia lythri* as found on *Epilobium* in this country.

Hainesia castaneae Oud. This species on *Castanea vesca* and *H. rostrupii* Oud. (1902) on *Quercus rubra* according to the original descriptions agree very closely with *H. lythri* except for slightly thicker conidia, and are probably identical. Authentic specimens, however, should be examined in order to verify this.

Tubercularia zythioides C. Massal. (1908). No authentic specimen of this species has been seen but judging from the original description and its association with a pycnidial form, *Sclerotiopsis rubi* C. Massal. which is apparently identical with *Sclerotiopsis concava,* this conidial form is the same as *Hainesia lythri.* The fungus was found on leaves of *Rubus caesius* in Italy and the author suggested that the fungus might be the conidial stage and the accompanying *Sclerotiopsis* the pycnidial stage of some unknown ascomycete. The present investigations have verified this prophesy in every particular.

Patellina fragariae Stev. & Pet. (1916). Authentic specimens of this species kindly supplied by Dr. Stevens and carefully compared and grown in culture leave no doubt that it is identical with *Hainesia lythri* (Desm.) v. Höhn. The form from strawberry is shown (*pl. 8, figs. 3, 4*).

II. Pycnidial Stage, Sclerotiopsis concava (Desm.) n. comb.

This is the earliest name as yet positively connected with the pycnidial stage of *Pezizella lythri.* During the winter following the discovery of his "*Dacryomyces*" on *Lythrum,* Desmazières found on dècaying leaves of *Rosa,* the branches of which had been cut the preceding summer, a fungus which he described as *Ceuthospora concava* (1847). An examination of his specimens

of this fungus in Pl. Crypt. France Ser. I, No. 1625 shows that there is a single cavity in the pycnidium as he stated and that there is no stroma, hence it could not be correctly referred to *Ceuthospora* whose type is *C. phacidioides*, which has a clypeate stroma enclosing several distinct pycnidia. However, like so many genera this was poorly defined and contained a group of very diverse species not congeneric. Desmazières' fungus proves to be identical with the pycnidial form of *Pezizella lythri* found on *Rosa, Rubus* and other hosts. Since this is the oldest specific name yet known to have been applied to the pycnidial form, it may be called *Sclerotiopsis concava* (Desm.) n. comb. The pycnidial form of *Pezizella lythri* is referred to the form genus *Sclerotiopsis* of Spegazzini (1882) because it is identical with his monotype of the genus, *S. australasica*, as shown by careful study of an authentic specimen of Spegazzini's species preserved in the herbarium of the New York Botanical Garden. Diedicke (1911) basing his interpretation of this genus apparently on that of Allescher (1901) and on *S. cheiri* described by Oudemans, and other forms previously referred to Phoma, revises the original diagnosis and includes several species with multilocular stromata clearly not congeneric with Spegazzini's type. V. Höhnel (1914) has already pointed out Diedicke's error in the interpretation of *Sclerotiopsis*. The latter's mistake might perhaps have been avoided if the type method of applying generic names had been followed and the application of Spegazzini's genus restricted to species congeneric with his monotype, *S. australasica*. Of course even then one might have such broad views of generic limits as to include forms having large multilocular stromata; but it seems best to the writers to keep such forms separate until more is known about the constancy and taxonomic value of such characters and the life histories of the organisms. On a basis of a comparison of morphological characters, one might be justified in regarding *Pilidium* Kunze (1823) as a synonym of *Sclerotiopsis* and in substituting Kunze's name for this pycnidial form. The monotype of Kunze's genus, *P. acerinum* Kze. (not *Leptothyrium acerinum* attributed to (Kunze) Cda. as found in some exsiccati, *e.g.*, D. Sacc. Myc. Ital. Nos. 762 and 974) is almost if not quite

identical in the structure of the pycnidium and scarcely differs from *S. concava* in any way except in the shape and size of the spores.

Leptothyrium macrothecium Fckl. Fuckel (1870) described this species from leaves of *Rosa, Potentilla, Quercus,* and *Rubus* in Germany. Specimens in his exsiccati, Fun. Rhen. Nos. 551, 553 and 1714 on leaves of the first three hosts respectively and others on leaves and stems of *Rubus* from Fuckel's herbarium have been examined. The specimens are identical with *Sclerotiopsis concava* (Desm.), the pycnidial form of *Pezizella lythri* found in America on a great variety of hosts. *Leptothyrium macrothecium* has been figured by Saccardo (1881) and by Laibach (1908). The latter has an excellent figure of a section of a pycnidium showing the character of the thick wall and a palisade-like layer of conidiophores extending across the base of the pycnidium. Laibach makes no mention of finding a conidial fungus corresponding to the *Hainesia* stage associated with the pycnidia.

No. 552, Fun. Rhen. was originally labeled *Leptothyrium macrothecium* f. *rhois* in Fuckel's herbarium. This form resembles the species superficially except that the surface of the pycnidium is somewhat rugose. The spores are 14–15 μ long. Noting these differences Fuckel later (1870) referred the fungus to *L. rhois* West. Westendorp's plant, however, as already pointed out (p. 154) is quite different from Fuckel's. Fuckel's form *Rhois* is not a *Gloeosporium* as stated by Saccardo (1884). The fungus agrees in all morphological characters except spore measurements with *L. macrothecium* and seems undoubtedly congeneric with it. Typical *L. macrothecium* has been frequently found on both native and introduced species of *Rhus* about Washington, but we have never found the form with large spores described by Fuckel. The occurrence of this second species of pycnidial fungus on *Rhus* seems to justify the belief that it belongs to a discomycete congeneric with *Pezizella lythri* and probably has a conidial form similar to *Hainesia lythri.* A pycnidial fungus very similar, if not identical, with this is *Pilidium acerinum* Kze. which occurs in Europe on *Acer* and *Carpinus* leaves. It has not

yet been reported in this country so far as we can learn. If this is found to be congeneric with *Sclerotiopsis,* as suggested above, the name *Pilidium* Kunze (1823) would displace *Sclerotiopsis* of Spegazzini (1882). A thorough search for the ascogenous and conidial stages of this fungus should be made where this *Pilidium* occurs.

The first report of the pycnidial form of *Pezizella lythri* on strawberry in this country was that of Saccardo (1913). The specimens were collected by Dearness, No. 3507 b, in Canada. A portion of this material kindly contributed by Professor Dearness is interesting, as it shows that besides the typical *L. macrothecium* pycnidia there are also present several sporodochia of the *Hainesia* stage. These seem to have been overlooked by Saccardo if they were on the specimens sent him.

LEPTOTHYRIUM PROTUBERANS Sacc. This specific name was first attributed by Saccardo (1882) to Lévéillé, as Saccardo thought at that time it was the *Phoma protuberans* of that author (1846). Saccardo was apparently misled by Roumeguere's application of Lévéillé's name to his No. 516 Fun. Sel. Gal. on *Coronaria myrtifolia,* which was the first specimen Saccardo referred to this species (1882). Later (1884), he recognized the mistake, dropped the citation of Lévéillé and used the name as his own. Saccardo mentions (1882, 351) that his *Leptothyrium protuberans* is closely related to *L. macrothecium.* An examination of Roumeguere's No. 516 in Ellis' herbarium shows that it is identical with *L. macrothecium* Fckl. and *Sclerotiopsis concava* (Desm.).

SPORONEMA DUBIUM C. Massal. Massalongo (1889 *a*) described this species from Italy on *Castanea.* A little later the same year (1889 *b*) the same species is described and illustrated with colored figures. Through the kindness of Dr. Massalongo we have been able to examine and compare part of the type collection of this species as well as two others described and figured at the same time. A study of these specimens shows that this species is identical with *Sclerotiopsis concava,* the pycnidial form of *Pezizella lythri.* Massalongo described the spores as catenulate. Whether they are slightly catenulate just before or

at maturity is very difficult to determine positively. When packed in the pycnidium before it ruptures the spores sometimes appear to be catenulate. If so it is an evanescent character and of little or no diagnostic value.

SPORONEMA QUERCICOLUM C. Massal. This was described (1889 *a*) and figured (1889 *b*) at the same time as *Sporonema dubium*. Examination of type material of this also shows that it is identical with our plant. This was said to differ from *S. dubium* in being argillaceous in color and dehiscing somewhat differently. Our study of many specimens of different age and condition shows that the color is variable, ranging from clay color through light brown and chestnut brown to black. Old specimens are usually darker than younger ones. The dehiscence of the pycnidia at maturity also varies greatly. *S. castaneae* C. Massal. (1889 *b*), which it was thought might also be a form of the same species, proves upon examination of part of the type to be specifically distinct, having considerably larger and differently shaped spores. This species appears to be identical with *Pilidium acerinum* Kze. (1823).

LEPTOTHYRIUM BORZIANUM F. Tassi (1896). This was found on *Jambosa* (*Eugenia*) *vulgaris* in the Botanical Garden at Siena, Italy. Tassi's figures show clearly the form of the pycnidia which he says are concave or collapsed when dry. The characteristic navicular spores borne upon branched conidiophores are also shown. We have seen no authentic specimens of Tassi's plant but we have found typical *Sclerotiopsis concava* on the same species of Jambosa in the greenhouses of the New York Botanical Garden which agree in all respects with Tassi's description and figure and which when cultured gave the typical sporodochia of *Hainesia lythri*. There seems scarcely any doubt, therefore, that Tassi's species is the pycnidial stage of *Pezizella lythri*.

SCLEROTIOPSIS POTENTILLAE Oud. (1900). This was found on *Potentilla* in Holland. Oudemans says this differs but little from S. *australasica* Speg. except that the spores are 1.5 μ longer. This slight variation in the length of spores is very common even in Spegazzini's own specimens. As the original description of Oudemans' agrees in every respect with *Sclerotiopsis concava* as

found on *Potentilla* in this country, we have no hesitation in regarding it as a synonym.

SCLEROTIOPSIS PELARGONII Scalia (1903). This was based on specimens that developed on leaves of *Pelargonium capitatum* in damp chamber in Italy. We have seen no authentic specimens of this species but the description applies in all particulars to specimens of *Sclerotiopsis concava* which developed on leaves of the same host in a damp chamber in our laboratory and also in nature on *P. zonale* in New Jersey. Sporodochia of *Pezizella lythri* have been found also in September on old leaves of *Geranium maculatum,* in the drug garden at Arlington Farm, Virginia.

SCLEROTIOPSIS RUBI C. Massal. (1906). This was found on dead spots on old leaves of *Rubus caesius* in Italy. The author compares the species with his *Sporonema dubium* and *Sclerotiopsis potentilla* Oud. The original description agrees entirely with that of pycnidia of *Pezizella lythri* as found on various species of *Rubus* from different localities in this country. Though we have seen no authentic specimens of Massalongo's species there seems to be no doubt that it is the same as *Sclerotiopsis concava* (Desm.).

SPORONEMA PULVINATUM Shear (1907). Comparison of the type specimen of this species, which was found on cranberry leaves kept in a moist chamber, shows that it is identical with the pycnidial form, *Sclerotiopsis concava.* We also find, upon examining the original material, other leaves in the same collection bearing amber-colored spore masses which had been referred provisionally to *Gloeosporium*; but which upon careful comparison now prove to be typical *Hainesia lythri.* Other specimens of the pycnidial form on *Vaccinium macrocarpum* have been collected in New Jersey and at Olympia, Washington. Judging from the character of the monotype of the genus *Sporonema* Desm. (1847) which is *S. phacidioides,* and also by study of its ascogenous stage, *Pyrenopeziza medicaginis* Fckl., which was demonstrated by Jones (1918), this is very closely related to *Sclerotiopsis* and *Pezizella oenotherae,* but it is apparently generically distinct.

Ceuthospora rubi Petrak (1911). This is apparently a *nomen nudum*, as we have been unable to find any description of it. The name is used on specimens distributed by Petrak in his exsiccati, Fl. Bohem. et Morav. No. 512 and was found on canes of *Rubus thrysoideus*. A specimen of this number which we have examined is identical with *Sclerotiopsis concava*.

III. Ascogenous Stage, Pezizella lythri (Desm.) n. comb.

Peziza (Mollisia) oenotherae C. & E. Cooke and Ellis (1878) described this discomycete which Ellis collected upon old stems of *Oenothera*. An examination of a part of the original material from Ellis' herbarium and also of the specimens distributed in North American Fungi Exsiccati No. 846 and Fungi Columb. No. 244 shows that this is identical with the discomycete which we have found on this same host and on various other hosts associated with the conidial and pycnidial form, and which has been demonstrated by single ascus cultures and inoculation to be identical. If the ascogenous form has ever been described or reported from Europe we have been unable thus far to find it. The discocarps have been found abundantly on old leaves of *Oenothera, Rubus, Gaura, Steironema, Prunus, Salix* and other hosts. They are generally accompanied by the pycnidial form and also usually by the conidial form as well.

Pezizella oenotherae (C. & E.) Sacc. Saccardo (1889) referred Cooke and Ellis' species to *Pezizella*. This was merely a transfer of the species to this genus and was not based on any new material or information.

Until we have much more knowledge of the life histories, comparative morphology and taxonomic value of the various characters and also can agree as to the generic types, it will be impossible to make any satisfactory disposition of the numerous genera and species of the discomycetes. In the meantime all attempts at classification must be regarded as tentative and of little value. The treatment of genera of discomycetes by the various systematists such as Phillips, Rehm, Boudier, Saccardo, von Höhnel and others is so diverse that one is left in a quandary as to what course to pursue in dealing with members of this group.

Mollisia, to which Cooke and Ellis referred this plant, seems to have been first used as a generic name by Karsten (1871), who includes 28 species, a considerable number of which he regarded as new. *Peziza cinerea* Batsch might perhaps be chosen as the type of *Mollisia,* as it is one of the common species included by Fries in his subgenus of the same name and is included in the first section by Karsten and Rehm. It is very doubtful, however, whether *M. cinerea* is congeneric with *Pezizella lythri.* Some idea of the confusion which exists in these genera may be derived from Von Höhnel's statement (1919) in regard to *Pezizella.* He says that his investigation of over 50 species, which have been referred to this genus, shows that they represent 23 different genera! As he does not specify to which of these 23 genera our species, *P. oenotherae,* belongs, we shall leave it for the present where Saccardo placed it, only adopting as the specific name the oldest one applied to any stage of the species so far as at present known.

SYNONYMS

The synonymy of each stage of the fungus is given below, also the exsiccati which have been cited and examined, the various illustrations which have been published and the distribution and hosts so far as at present known.

In connection with distribution and hosts it seems somewhat remarkable that so few collections of any of the three stages of this fungus should have been made or reported heretofore in this country; and especially in view of the variety of hosts upon which it occurs and its abundance the past season in several widely separated localities. This indicates quite forcibly the scantiness of our knowledge of our mycological flora and the great need of more systematic collection and study before we can hope to know what species occur or their distribution as to localities or host plants.

PEZIZELLA LYTHRI (Desm.) n. comb.

I. CONIDIAL STAGE, HAINESIA LYTHRI (Desm.) v. Höhn.

1. *Dacryomyces lythri* Desm. Pl. Crypt. France No. 1545. 1846.
2. *Sphaeronema corneum* C. & E. Grev. **6**: 84. 1878.
*3. *Gloeosporium? tremellinum* Sacc. Michelia **2**: 168. 1880.
4. *Gloesporium? rhoinum* Sacc. Fungi Italici, Pl. 1035. Jl. 1881.

*5. *Hainesia rhoina* (Sacc.) Ell. & Sacc. Syll. Fun. **3**: 699. 1884.
6. *Tubercularia rhois* Halsted. Seymour & Earl. Economic Fungi No. 273. 1893. Also Bull. Torr. Bot. Club **20**: 251. 1893.
*7. *Hainesia epilobii* Eliasson. Bih. K. Sv. Vet. Akad. Handl. III, **22**: 16. 1896.
*8. *Hainesia castaneae* Oud. Ned. Kruid. Archief Ver. Med. Ned. Bot. Ver. III, **2**: 755. 1902.
*9. *Hainesia rostrupii* Oud. Ned. Kruid. Archief Ver. Med. Ned. Bot. Ver. III, **2**: 756. 1902.
10. *Hainesia lythri* (Desm.) v. Höhn. Frag. Myc. (in Sitz. Akad. Wiss. Wien. **115**: 687. 1906).
*11. *Tubercularia zythioides* C. Massal. Madonna Verona 2: 39. 1908.
12. *Hymenula rhoina* (Sacc.) Bub. & Kab. Kabát & Bubák, Fungi Imp. Exs. No. 749. 1910.
13. *Patellina fragariae* Stevens & Peterson. Phytopathology **6**: 264. 1916.

II. PYCNIDIAL STAGE, SCLEROTIOPSIS CONCAVA (Desm.) n. comb.

1. *Ceuthospora concava* Desm. Ann. Sci. Nat. Bot. Ser. III. **8**: 17. 1847.
2. *Leptothyrium macrothecium* Fckl. Symb. Myc. 383. 1870.
3. *Leptothyrium protuberans* Sacc. Michelia **2**: 351. Mr. 1881. Syll. Fun. **3**: 635. 1884.
4. *Sclerotiopsis australasica* Speg. Ann. Soc. cien. Arg. **13**: 14. 1882.
5. *Sporonema dubium* C. Massal. Nuovo Giorn. Bot. Ital. **21**: 166. Apr. 1889.
6. *Sporonema quercicolum* C. Massal. Nuovo Giorn. Bot. Ital. **21**: 166. Apr. 1889.
*7. *Leptothyrium borzianum* F. Tassi. Rev. Myc. **18**: 171. pl. 173 F. 1896.
*8. *Sclerotiopsis potentillae* Oud. Ned. Kruid. Archief III Ver. Med. Ned. Bot. Ver. **2**: 248. 1900.
*9. *Sclerotiopsis pelargonii* Scalia. Mycetes Siculi Novi. II. 2. 1903.
*10. *Sclerotiopsis rubi* C. Massal. Malpighia. **20**: 166. 1906.
11. *Sporonema pulvinatum* Shear. Bull. Torr. Bot. Club **34**: 308, 309. 1907.
12. *Ceuthospora rubi* Petrak. nomen nudum. Flora Bohem. et Morav. Exs. No. 512 II Ser. 1 Abt. Lfg. 11. 1912.

II. ASCOGENOUS STAGE, PEZIZELLA LYTHRI (Desm.) n. comb.

1. *Peziza* (Mollisia) *oenotherae* C. & E. Grev. **6**: 90. Mr. 1878.
2. *Pezizella oenotherae* (C. & E.) Sacc. Syll. **8**: 278. Dec. 20, 1889.

* No authentic specimens seen.

EXSICCATI EXAMINED

HAINESIA LYTHRI.

Desmazières, J. B. H. J. Pl. Crypt. France 1545 as *Dacryomyces lythri* Desm. 1846.

Ellis & Everhart. N. A. Fun. 846. *Peziza oenotherae* C. & E. with sporodochia (*Sphaeronema corneum*, C. & E.). 1881 or 1882.

Seymour & Earle. Econ. Fun. 273. *Tubercularia rhois* Halsted. 1893.

Ellis & Everhart. Fun. Col. 244. *Peziza oenotherae* C. & E. with sporodochia also in the four sets examined. 1894.

Ellis & Everhart. N. A. Fun. 2074. *Sphaeronema corneum* C. & E.

Ellis & Everhart. N. A. Fun. 2278. *Hainesia rhoina* (Sacc.) Ell. & Sacc.

Kabát & Bubák. Fun. Imp. Exs. 749. *Hymenula rhoina* (Sacc.) Bub. & Kab. 1910.

SCLEROTIOPSIS CONCAVA.

Desmazières. Pl. Crypt. France 1625. *Ceuthospora concava* Desm. 1847.

Fuckel. Fun. Rhen. 551, 553, 1714. *Leptothyrium macrothecium* Fckl. 1870.

Roumeguère, C. Fun. Sel. Gal. 516. *Phoma protuberans* Lév. 1879.

Vestergren, T. Mic. Rar. Sel. 61. *Leptothyrium protuberans* Sacc. 1882.

Ellis & Everhart. N. A. Fun. 733. *Leptothyrium protuberans* Sacc. 1881.

Ellis & Everhart. Fun. Col. 287. *Leptothyrium protuberans* Sacc. 1894.

Ellis & Everhart. Fun. Col. 244. *Peziza oenotherae* C. & E. with pycnidia and sporodochia. 1894.

Petrak. Fl. Boh. & Morav. Exs. Ser. II, 1 Abt. 512. "*Ceuthospora rubi* n. sp." 1912.

PEZIZELLA LYTHRI.

Ellis & Everhart. N. A. Fun. 846. *Peziza oenotherae* C. & E. 1881 and 1882. Only the conidial stage, *Hainesia lythri,* on specimens of this number in Herb. U. S. Dept. Agr. and N. Y. Bot. Garden.

Ellis & Everhart. Fun. Col. 244. *Peziza oenotherae* C. & E. 1894.

Ellis & Everhart. Fun. Col. 287. *Leptothyrium protuberans* Sacc. 1894. The discocarps are also found with this in the specimens of one set of this number in the Herb. N. Y. Bot. Garden.

ILLUSTRATIONS

CONIDIAL STAGE.

Saccardo. Fungi Ital. pl. 1035. 1881.

Saccardo. Fungi Ital. pl. 1039. 1881.

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PYCNIDIAL STAGE.

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Massalongo, C. Mem. Accad. Agr. Verona Ser. III. **65**: pl. 3, fig. XIX, XX. 1889.

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Oudemans. Med. Kruid. Archief III. **2**: pl. 1, fig. 6. 1900.

Shear. U. S. Dept. Agr. Plant. Ind. Bull. 100, pl. 5, figs. 25–28. 1907

Laibach. Arb. K. Biol. Anst. Land. u. Forst. **6**: 79. fig. 2. 1908.

Allescher. Rab. Crypt. Fl. 1: Abt. 7: 318, 334, 338. 1903.

Distribution

Americas. The fungus has been found in one or more of its three fruiting conditions in Ontario (Canada), Maine, Massachusetts, New York, New Jersey, Maryland, District of Columbia, Virginia, North Carolina, Georgia, Florida, Wisconsin, Minnesota, Ohio, Tennessee, Louisiana, Texas, Washington (United States), and Argentina (South America).

Europe. Sweden, Holland, France, Germany, Bohemia, Italy.

Hosts

In the Americas the conidial stage has been found on dead spots on living leaves, or on mature fruit, dead leaves, petioles or stems of the following plants: *Acer rubrum, Ampelopsis quinquefolia, Castanea dentata, Castanea* (*dentata* × ?), *Cercis canadensis, Cornus canadensis, Duchesnia indica, Epilobium angustifolium, Eucalyptus globulus, Fragaria virginiana, F. virginiana chilocnsis, F. mexicana, Gaultheria procumbens, Gaura biennis, Hicoria glabra, Jambosa* (*Eugenia*) *vulgaris, Lythrium salicaria, Nyssa sylvatica, Oenothera biennis, Vaccinium macrocarpum, Pelargonium capitatum, Pelargonium zonale, Populus nigra italica, Potentilla canadensis, Prunus serotina, Quercus alba, Q. rubra, Q. velutina, Rhus copallina, R. glabra, R. cotinus, R. toxicodendrum, R. typhina, Ribes prostrata, Rosa rugosa prostrata, Rubus occidentalis* var. (cult. black raspberry), *R. strigosus* var. (cult. red raspberry), *R. idaeus, R. setosus, Rubus* spp. (wild blackberry), *Rubus villosus* var. (Lucretia dewberry), *Salix humilis, Smilax rotundifolia, Ulmus* sp., *Vitis cordifolia.*

The pycnidial stage has been found on all of the above hosts with the exception of *Ampelopsis, Cercis, Cornus, Duchesnia, Geranium* and *Ribes.*

The ascogenous stage has been found on *Castanea* (*dentata* × ?), *Gaura biennis, Oenothera biennis, Prunus serotina, Steironema ciliata, Rubus strigosus idaeus* (cult. var.), *R. villosus* var. (Lucretia dewberry) and *Rubus* sp. (wild blackberry).

All hosts from the United States and Canada except the following are here reported for the first time: *Fragaria, Oenothera, Rhus, Rubus,* and *Vaccinium.*

CONCLUSION

Too much emphasis cannot be placed upon the great need for serious and concentrated effort in improving the conditions in mycology, which are so strikingly illustrated by the results of the present study. With such confusion prevailing in the taxonomy and such lack of knowledge of the morphology of the fungi as is here indicated, it is imperative that all mycologists and pathologists should unite in trying to remedy these conditions and to establish a fairly stable system of nomenclature and terminology for the fungi. The most practical and effective plan yet suggested for establishing generic names is to fix a type species for each genus, which shall furnish a basis for a definite application and interpretation of the genus. We cannot hope for complete agreement as to the exact limitations of genera, but the application of the generic type method would at least insure that a certain species or small group of species would always be inseparable from the generic name. This would certainly be a great improvement over the present practice so frequently followed of shifting the generic name from one species or group of species to another group with little or no consideration for the original species of the genus.

This work also emphasizes the need of more careful study and comparison of all the morphological characters of the different forms or stages of the pleomorphic fungi. The various conidial and pycnidial fructifications when thoroughly studied and compared in detail will, we believe, show points of resemblance or difference which can be coördinated with their relationships to each other and to their perfect stages. Such knowledge combined with that derived from life history studies will probably provide the best foundation for determining the natural relationships of genera and species as well as the higher groups. The failure to appreciate the significance of the confusion and lack of knowledge of various genera involved in the present taxonomic practice has apparently lead some to think that the conidial and pycnidial stages of ascomycetes show no consistent resemblances or differences of taxonomic value, and are therefore of little or no use in determining the relationships of genera and

species. It is said, for example, that species of *Gloeosporium* are conidial forms of such diverse and distantly related ascomycetes as *Glomerella* and *Pseudopeziza*. When, however, one studies and compares carefully the so-called species of *Gloeosporium* involved, it is found that they are very different, and could not on a purely morphological basis be considered congeneric. The present genus *Gloeosporium* as treated by Saccardo, for example, contains a heterogeneous collection of many imperfectly known and poorly described forms, really belonging to various and sometimes widely separated genera having in some cases only very slight superficial resemblances. The same is true of most of the large genera of the so-called fungi imperfecti.

SUMMARY

This paper contains an account of the life history, morphology and taxonomy of a discomycete, *Pezizella lythri* (Desm.) Shear and Dodge, which is found on a great variety of plants and plant parts and has three stages in its life cycle: sporodochia, pycnidia and apothecia.

The conidial stage has received at least seven generic and ten specific names. It belongs to the form genus *Hainesia* and was described as the monotype of that genus. Its first specific name so far as at present known is *lythri,* it having been described as *Dacryomyces lythri* by Desmazières in 1846. The new combination *Hainesia lythri* (Desm.) was proposed by von Höhnel in 1906.

The pycnidial stage has also been described under various generic and specific names. It has been referred to at least four different genera and has had at least twelve specific names. It is the type of the genus *Sclerotiopsis* and its oldest specific name at present known is *concava,* it having been described at *Ceuthospora concava* by Desmazières in 1847. The new combination, *Sclerotiopsis concava* (Desm.) Shear and Dodge is therefore proposed for it.

The ascogenous or perfect stage has been described but once so far as known. Cooke & Ellis described it as *Peziza* (Mollisia) *oenotherae* in 1878 from stems of *Oenotherae biennis* collected

in New Jersey. Later Saccardo transferred it to the genus *Pezizella* as *P. oenotherae* (C. & E.) Sacc. It is left for the present in this genus. Adopting, however, the oldest known specific name applied to any stage, it becomes *Pezizella lythri* (Desm.) new combination.

This fungus in one or another of its stages has been found on about fifty different host plants widely distributed through North America and Europe, and is also found in South America.

The cultural and morphological characteristics of the various stages are described.

Cross inoculation experiments show that the fungus is a weak parasite and passes readily under favorable conditions from one host to another.

The chaos which at present prevails in the taxonomy and morphology of the ascomycetes is discussed and the imperative need of establishing a more stable system of nomenclature pointed out. The application of the type method, it is believed, would accomplish this end.

The great need and importance of life history studies is emphasized, as such studies will supply important data for determining the natural relationships of the genera and species of fungi and also furnish information of exceeding value and direct bearing on phytopathological problems.

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EXPLANATION OF PLATES 8–10

PEZIZELLA LYTHRI (Desm.) Shear & Dodge

PLATE 8. Conidial stage, *Hainesia lythri* (Desm.) v. Höhn.

Fig. 1. Small sporodochia on white carpel of dewberry, also mycelia of moulds that often follow this fungus. × 10.

Fig. 2. Large sporodochia on red raspberry, two showing irregularly lobed margin. × 15.

Fig. 3. Sporodochia on strawberry showing conical mass of conidia. × 10.

Fig. 4. Typical forms on strawberry. × 15.

Fig. 5. Two sporodochia from old cultures on cut surface of apple. The one at left developed normally, that on right remained closed and became darkened. It contained mature spores. × 15.

Fig. 6. Sporodochia from the same cultures as fig. 5. These resemble pycnidia with large ostioles from which broad, white cirrhi of spores are protruding. × 15.

Fig. 7. Mature sporodochia on agar. The spore masses have become heavy so that most of the sporodochia have fallen over showing the stalk-like basal portions. × 10.

FIG. 8. Sporodochium from the same culture as fig. 7, after the spore mass was removed showing the cup shaped body with lobed margin. × 20.

Fig. 9. Section of young cylindrical sporodochium from strawberry. The sporophores from the base are much longer than those from the sides. × 100.

Fig. 10. Section of a conidial fructification from strawberry. The spore mass free from the sporophores. × 300.

PLATE 9. Pycnidial stage, *Sclerotiopsis concava* (Desm.) Shear & Dodge

Fig. 11. Pycnidia on cane of black raspberry. Note the lines radiating from each pycnidium showing the effect of the fungus in causing a wrinkling of the host tissues.

Fig. 12. Pycnidia on dead leaf of *Steironema ciliatum* showing concave condition of the mature, dried fruit body, dehiscence not yet occurred. × 2½.

Fig. 13. Immature pycnidia on leaf of *Epilobium*. × 12.

Fig. 14. Pycnidia on dewberry canes. The longitudinal cracks show where the cuticle has ruptured. The walls of the pycnidia are still unbroken. × 15.

Fig. 15. Pycnidia from the specimen shown in Fig. 11, but more highly magnified to show the irregular cracking of the pycnidial wall in dehiscence.

Fig. 16. Section of a very small mature pycnidium showing the original orientation of cells in the upper wall and the middle, dark colored tissue in the basal wall. × 240.

Fig. 17. Cross section of an overwintered pycnidium on dewberry cane, showing the cuticle and the cuticularized layer of the epidermis tightly stretched, and region at the center showing where the walls of spores are being transformed into a mucilaginous substance the swelling of which bursts the pycnidium. × 80.

PLATE 10. Ascogenous stage, *Pezizella lythri* (Desm.) Shear & Dodge (except fig. 18).

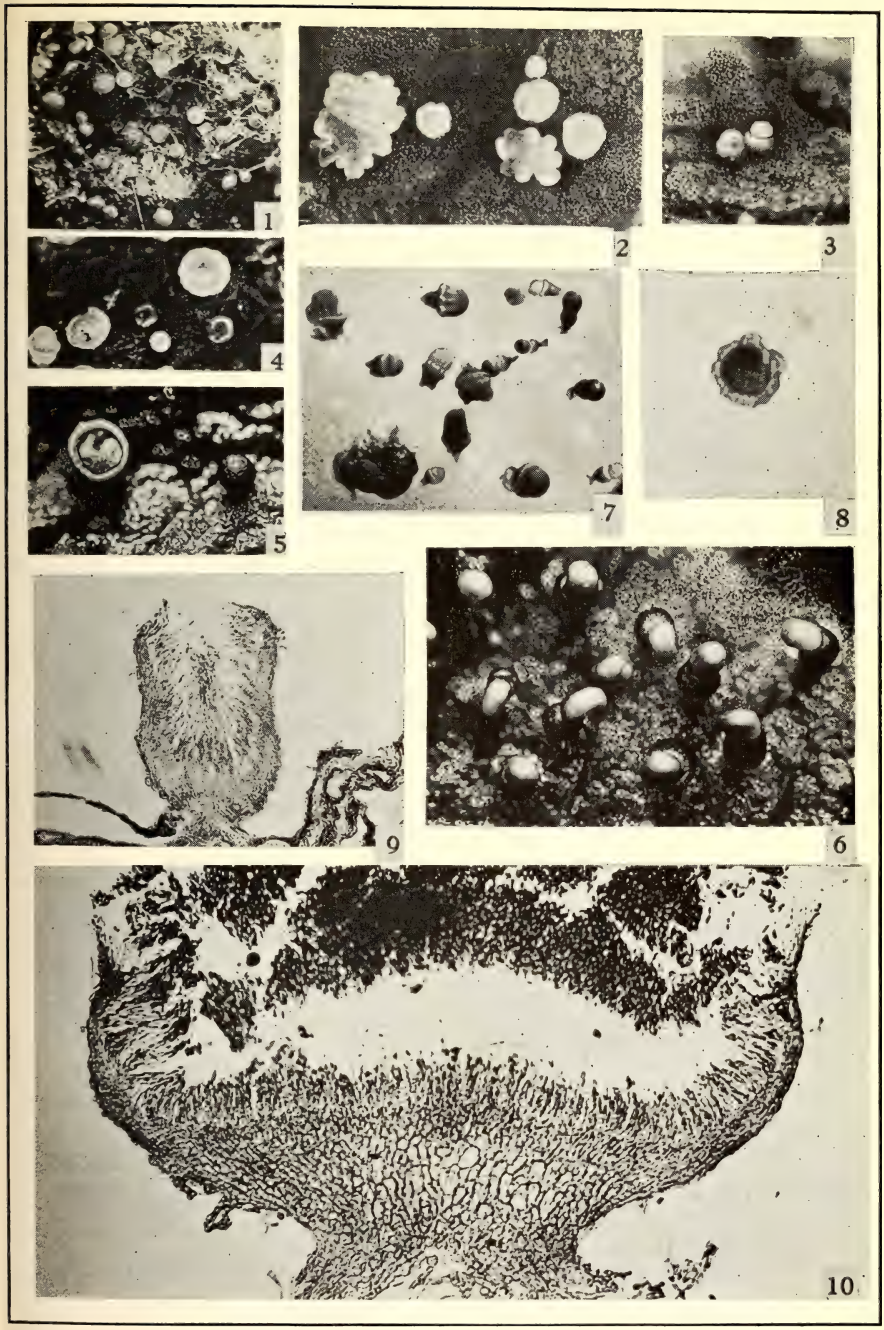
Fig. 18. An old sporodochium (*a*) and a young pycnidium (*b*) on rotting strawberry. The spore cavity in the pycnidium is just being formed. The dark colored middle layer of the wall along the base is well shown here. × 80.

Fig. 19. Section of a mature discocarp from dewberry. The spores are deeply stained. × 300.

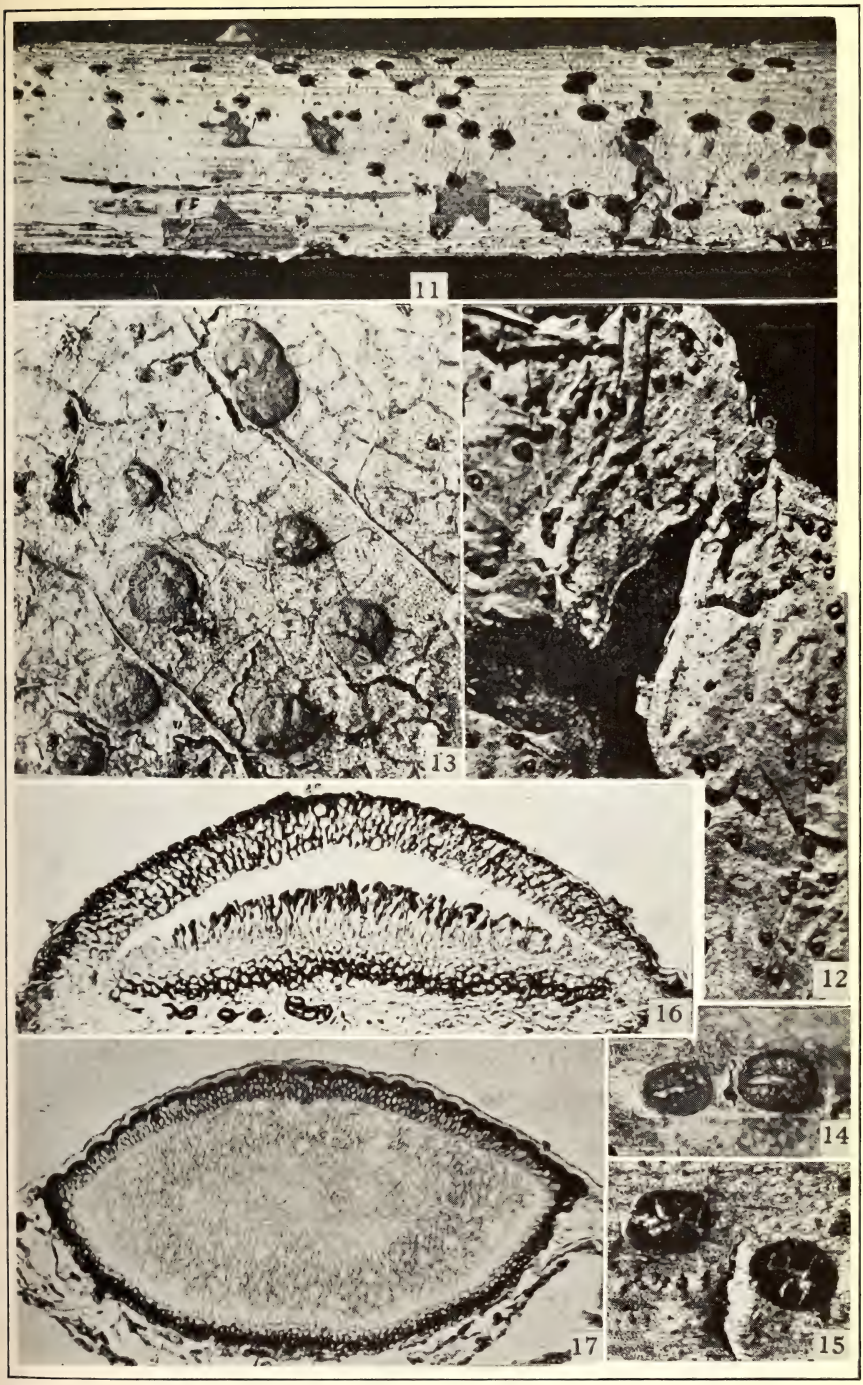
Fig. 20. Section of a discocarp showing a stalk-like base, from leaf of wild blackberry. The discocarps originate intraepidermally. This is evident as portions of epidermal cells are clearly seen at the base. × 150.

Fig. 21. Part of a section of a discocarp highly magnified, showing the arrangement of the spores in the asci, and the paraphyses projecting above the asci. × 600.

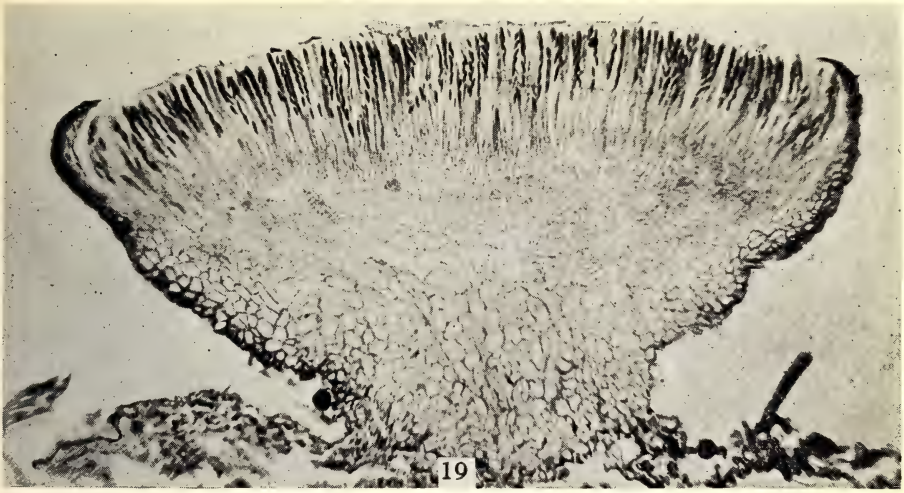
Fig. 22. Small but old discocarp from dewberry leaf showing portions of the epidermis among the cells at the base. × 150.

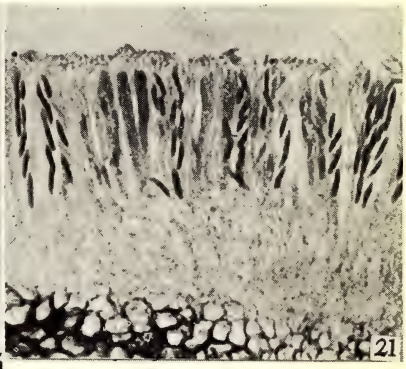


PEZIZELLA LYTHRI (DESM.) SHEAR & DODGE



SCLEROTIOPSIS CONCAVA SHEAR & DODGE





PEZIZELLA LYTHRI (DESM.) SHEAR & DODGE

LIGHT-COLORED RESUPINATE POLYPORES—IV

William A. Murrill

The last article, devoted to red or reddish species, appeared in the March number of *Mycologia.* In the present article, I propose to discuss some of the resupinate forms in which yellow is the predominant color.

74. Poria aurea Peck, Ann. Rep. N. Y. State Mus. 43: 67. 1890

Described as follows from specimens collected by Peck at Sevey, New York, in July on decaying wood of sugar maple :

"Effused, forming patches several inches in extent, 2 to 3 lines thick, separable from the matrix, golden yellow; subiculum thin, sub-gelatinous, the young margin byssoid or fimbriate, greenish-yellow, soon disappearing; pores small, subrotund, elongated, the dissepiments thin, rather soft."

This species, which seems to occur on both deciduous and coniferous wood, has been confused with *Poria subacida,* even by Peck himself. According to Overholts, the spores are oblong or short-cylindric, smooth, hyaline, 5.5–7.5 × 2.5–3.5 μ; cystidia large, hyaline, abundant, projecting. I find the types to be near *P. subacida,* but a richer golden-yellow and apparently more fragile.

75. Poria sulphurella (Peck) Sacc. Syll. Fung. 9: 190. 1891

Polyporus sulphurellus Peck, Ann. Rep. N. Y. State Mus. 42: 123. 1889.

Described as follows from specimens collected by Peck in September on dead poplar bark in the Catskill Mountains:

"Resupinate, effused, very thin, following the inequalities of the matrix; subiculum and margin downy, white; pores very short, minute, rotund, very pale-yellow, often with a slight salmon tint, the dissepiments obtuse."

The types are well preserved at Albany, and Overholts has found the spores to be cylindric or allantoid, hyaline, 3–5 × 1–2 μ; cystidia none.

76. PORIA LEUCOLOMEA (Lév.) Cooke, Grevillea **14**: 112. 1886

Polyporus leucolomeus Lév. Ann. Sci. Nat. III. **5**: 140. 1846.

Described as follows from specimens collected by Ménand at New York City, probably on red cedar:

"Pileo tenui resupinato undique adnato, margine albo tomentoso sterili, poris mediis superficialibus angulatis ore lacerato-dentatis ochraceo-fulvis.

"Chapeau large de 2 à 4 centimètres, membraneux, adhérent par tous ses points. Cette espèce se distinguera facilement à ses pores, qui sont d'un jaune fauve, ainsi que par sa marge blanche, tomenteuse et stérile."

This species was not found at Kew, and my notes made at Paris contain no mention of it. The description is inadequate without a look at the type. Compare *Poria subincarnata.*

77. PORIA VITELLINA (Schw.) Cooke, Grevillea **14**: 110. 1886

Boletus vitellinus Schw. Schr. Nat. Ges. Leipzig **1**: 100. 1822.

Described as follows from specimens collected by Schweinitz on dead wood in North Carolina:

"Subexpansa molliuscula, margine byssino, poris magnis elevatis opacioribus.

"Rarus fungus in fissuris lignorum, maxime putridorum, nidulat. Color pulcherrime vitellinus, post exsiccationem remanet. Pori molles."

Several different plants have been determined as this species by Morgan, Ellis, and others, but I have seen none so named that appear to match the very fragmentary types at Kew. If the species were white, I should place it near *Poria incerta.*

78. PORIA AURANTIOPALLENS (Berk. & Curt.) Cooke, Grevillea **14**: 112. 1886

Polyporus aurantiopallens Berk. & Curt. Grevillea **1**: 53. 1872.

Described as follows from specimens collected on pine in South Carolina:

"Suborbicularis, margine elevato obtuso cinctus; poris parvis.

"About an inch wide; margin obtuse raised; pores 1/90 inch wide. Allied apparently to *P. bombycinus*."

The type at Kew is 1.2 cm. in diameter and 1–2 mm. thick; margin elevated, whitish-pubescent; tubes pale-orange-yellow; context firm.

79. PORIA TEGILLARIS Berk. Grevillea **15**: 25. 1886

Described as follows from specimens in Berkeley's herbarium collected on dead wood in Carolina:

"Effusa, indeterminate, tenuissima, flavo-fuscescens, substrato obsoleto; poris aequalibus, rotundatis, minimis, dissepimentis tenuibus.

"Reduced to a mere porous stratum following the inequalities of the wood."

Little idea can be gained of this species by seeing the type, and it is a pity that Cooke published Berkeley's name.

80. PORIA CHRYSOBAPHA (Berk. & Curt.) Cooke, Grevillea **14**: 113. 1886

Polyporus chrysobaphus Berk. & Curt. Grevillea **1**: 53. 1872.

Described as follows from specimens collected by Peters in Alabama:

"Totus resupinatus, immarginatus, aureo-olivaceus; poris elongatis obliquis; sporis ferrugineis. No. 6342. Alabama. Peters.

"Entirely resupinate without any distinct margin; of a golden yellow, inclining to olive; pores elongated, oblique, 1/36 inch wide; spores ferruginous."

The type at Kew is so very poor, being a mere fragment 2 × 1 cm., that it is difficult to get a true idea of the plant from it; but the olive-yellow tubes and ferruginous spores should be quite characteristic. Compare a specimen from Ohio so determined by Morgan.

81. PORIA FLAVIPORA Berk. & Curt. Grevillea **15**: 25. 1886

Described as follows from specimens collected on dead wood in Venezuela by Fendler.

"Effusa, indeterminata, tenuis, alutaceo, v. ochraceo-favida, margine radiante, tenuiore, albido; poris inaequalibus, minimis, angulatis, confluentibusque, dissepimentis tenuibus, acutis."

Types have been examined at Kew and also in the Garden herbarium.

82. **Poria ochracea** sp. nov.

Effused for many centimeters, continuous so far as the substratum will allow, inseparable, 1 mm. thick; margin wide and conspicuous in young stages, thin, appressed, membranous, tomentose, pallid, becoming much reduced in age; context pallid, not apparent in age; hymenium somewhat uneven, appearing in patches on the subiculum and becoming continuous, not glistening, ochraceous when fresh, isabelline in dried specimens; tubes large, firm, angular, very regular, thin-walled, entire, 1 mm. long, 2–3 to a mm.; spores smooth, pip-shaped, hyaline, $4.5 \times 2\,\mu$; no cystidia observed.

Type collected on a decayed fallen oak limb in mixed woods at Crabbottom, Virginia, 3,000 ft. elevation, July 17–21, 1904, *W. A. Murrill 183*.

83. **Poria flavida** sp. nov.

Effused for several centimeters, continuous, inseparable, 1–3 mm. thick; margin conspicuous in young stages, very thin, appressed, membranous, yellow, more or less disappearing with age; context thin, pallid, soon inconspicuous; hymenium arising in patches, becoming almost continuous, rather uneven, not glistening, a fine yellow when fresh, discolored-isabelline in dried specimens; tubes very large, angular, irregular, about 1 to a mm., the edges very thin, entire to lacerate, soft, fragile, and collapsing; spores ellipsoid, smooth, hyaline, uniguttulate, copious, $5 \times 3.5\,\mu$; cystidia not observed.

Type collected on decayed pieces of pine timber at Pointe à la Hache, Louisiana, in 1886, *A. B. Langlois 54*. Another packet collected by Langlois at the same place January 17, 1886, contains golden-yellow mycelium which grew in sawdust in pine

woods. This may belong to the same fungus, but one can not be certain of it.

84. **Poria Calkinsii** sp. nov.

Effused for a few or several centimeters, becoming continuous, 1–2 mm. thick; margin conspicuous, appressed, tomentose, isabelline in dried specimens; context a distinct isabelline membrane; hymenium first appearing at the center of circular patches of subiculum, becoming continuous, even, glistening, isabelline in dried specimens; tubes firm, angular, regular, 1–2 mm. long, 4 to a mm., edges at first rather thick and entire, becoming thin and lacerate; spores broadly ellipsoid, smooth, hyaline, rounded at the ends, uniguttulate, $4 \times 2.5\,\mu$.

Type collected on fallen corticated hardwood branches in Florida, *W. W. Calkins 521*. What appears to be the same species was collected by Ellis on dead maple limbs at Newfield, New Jersey, in October, 1874.

85. **Poria Parksii** sp. nov.

Entire plant pale-yellow when fresh, becoming distinctly flavous on drying; effused for a few centimeters, continuous, separable, thin; margin conspicuous, tomentose, more or less membranous; context like the margin; hymenium becoming continuous, rather even, not glistening; tubes short, small, thin-walled, with entire to lacerate edges, the mouths circular at first, becoming angular and longer than broad; spores copious, smooth, hyaline, subglobose, uniguttulate, $4\,\mu$; cystidia none.

The type of this unusually attractive, bright-yellow species was collected beneath leaves on roots of tan-bark oak in a dense oak forest at the Boys' Outing Farm, Saratoga, California, January 13, 1921, *Harold E. Parks 965*. Said by Mr. Parks to have been collected at the same place in February, 1919, and sent to the University of California. Growing in this way under a heavy deposit of leaves, the specimens I have seen may be abnormally developed.

86. **Poria subradiculosa** sp. nov.

Effused for several centimeters, becoming continuous, inseparable, 2–4 mm. thick; margin very broad and conspicuous in young stages, thin, appressed, membranous, white to orange-

yellow, often connected with long, branching, rhizomorphic strands; context membranous, white or yellowish, varying in thickness; hymenium appearing in patches, becoming continuous and somewhat abnormally vesiculose, uneven, not glistening, bright-orange-yellow when fresh; tubes large, irregular, angular, 1–3 mm. long, 1–2 to a mm., edges thin, collapsing and becoming lacerate with age; spores ellipsoid, smooth, hyaline, copious, about $5 \times 2.5\,\mu$.

Type collected on decayed pine bark and leaves at Biloxi, Mississippi, September 6, 1904, *Mrs. F. S. Earle 40.*

What apears to be a form of the same thing was collected on the under side of pine chips at Auburn, Alabama, January, 1896, by L. M. Underwood. The mycelium was yellow when fresh, widely creeping, the smaller strands whitish; subiculum cottony-flocculent, yellowish, forming at first irregular, thin-walled tubes without the development of any further context; mature tubes irregularly labyrinthiform, deep-golden-yellow, 1–2 to a mm., edges entire, soft when fresh. The spores are ellipsoid, tapering obliquely at one end, smooth, hyaline, copious, $6–7 \times 3–4\,\mu$; no cystidia seen. The mature tubes look quite different from those in Mrs. Earle's specimens, which latter are rather vesiculose and abnormal.

This species differs from *Poria subacida* in its bright-orange-yellow color, larger tubes, broad margin, and conspicuous rhizomorphic strands. One would naturally think of *Poria xantha* Pers. in this connection; but South Carolina specimens so named sent to Upsala by Berkeley are only the yellow form of *Poria medullapanis*. The description of *Poria vitellina* seems to fit the plant fairly well, but Schweinitz' types are very distinct. Underwood determined his specimens as *Poria chrysoloma* Fries, a species confined to Europe so far as I know.

87. **Poria flavilutea** sp. nov.

Effused for several centimeters, continuous, inseparable, about 1 mm. thick; margin at first conspicuous, byssoid, thin, appressed, white, becoming inconspicuous with age; context white, scarcely apparent in age; hymenium even, regular, scarcely glistening, flavo-luteous in dried specimens; tubes angular, quite regular ex-

cept when varied by obliquity, thin-walled, entire, 1 mm. long, 4 to a mm.; spores ellipsoid, smooth, hyaline, $5 \times 3.5\,\mu$; no cystidia observed.

Type collected on much-decayed fallen branches and moss-covered roots at Rio Piedras, Porto Rico, November 19, 1911, *J. R. Johnston 97*.

88. **Poria jalapensis** sp. nov.

Effused for many centimeters, continuous, inseparable, 1–2 mm. thick; margin slight, tomentose, white, inconspicuous in age; context white, conspicuous and punky in places; hymenium mostly uneven, nodulose or following the inequalities of the substratum, not glistening, distinctly ochraceous in dried specimens; tubes angular, very regular, firm, rather thin-walled, 1 mm. long, 4 to a mm., the edges produced into short, sharp teeth; spores ellipsoid, smooth, hyaline, $5 \times 3\,\mu$; no cystidia observed.

Type collected on a decayed hardwood trunk in a moist virgin forest at Jalapa, Mexico, December 12–20, 1909, *W. A. & Edna L. Murrill 252*.

89. DAEDALEA SULPHURELLA Peck, Ann. Rep. N. Y. State Mus. 44: 133. 1891

Described as follows from specimens collected by Peck on much-decayed wood at Salamanca, New York, in September:

"Resupinate, effused or nodulose, pale sulphur yellow; pores short, labyrinthiform, the dissepiments often lacerated and irpiciform in the dry plant; spores subglobose or broadly elliptical, .0002 in. long.

"Mostly very irregular or nodulose, following the irregularities of the wood and encrusting mosses. It is of a beautiful pale yellow color when fresh, but it changes to a dull pallid hue when dry."

The type at Albany is very poor, consisting mainly of a few coarse teeth that suggest litle. Overholts finds the spores to be ellipsoid or globose, hyaline, $5–6 \times 4–5\,\mu$, and says that the mature fragments seem more like an *Irpex* than a *Daedalea*. Fresh specimens would be highly desirable.

OTHER YELLOW SPECIES

Poria calcea Fries, var. *sulphurea*. Romell so determined specimens collected by me on a white pine log in Maine, August 28, 1905, which were distinctly lemon-yellow when fresh. I have not studied this species very carefully, as the specimens are apt to be sterile.

Poria cremeicolor Murrill. Very pale yellow. See Mycologia **12**: 85. 1920.

Poria fatiscens (Berk. & Rav.) Cooke. Sulphur-yellow to chrome-yellow, at least in herbarium specimens. See Mycologia **11**: 238. 1919.

Poria heteromorpha Murrill. Distinctly ochraceous, becoming fulvous with age. See Mycologia **12**: 92. 1920.

Poria incerta (Pers.) Murrill. The herbarium specimens of this common, variable species are often pale-yellowish. See Mycologia **12**: 78. 1920.

Poria medullapanis (Jacq.) Pers. Often a beautiful egg-yellow or chrome-yellow, especially on the margin of young plants; hence the names *P. pulchellus* and *P. holoxantha* assigned to American material. See Mycologia **12**: 48. 1920.

Poria myceliosa Peck. Tubes pale-yellow. See Mycologia **12**: 301. 1920.

Poria radiculosa (Peck) Sacc. Orange-yellow. See Mycologia **12**: 301. 1920.

Poria semitincta (Peck) Cooke. Tubes usually pale-yellow. See Mycologia **12**: 300. 1920.

Poria subacida (Peck) Sacc. Usually pale-yellow when fresh, becoming much deeper yellow in the dried condition. Orange tints are sometimes present. See Mycologia **12**: 79. 1920.

Poria subsulphurea (Ellis & Ev.) Murrill. Pale-yellow. See Mycologia **11**: 242. 1919.

Poria xantholoma (Schw.) Cooke. Margin described as elegantly luteous, tubes pallid. See Mycologia **11**: 234. 1919.

Xanthoporia Andersoni (Ellis & Ev.) Murrill. Tubes at first whitish, soon colored yellow by the abundant spores.

NEW YORK BOTANICAL GARDEN.

SMUTS AND RUSTS OF NORTHERN UTAH AND SOUTHERN IDAHO

GEORGE L. ZUNDEL

The fungi listed in the following paper were secured from two principal sources. In the first place the author collected a number of smuts and rusts while on his vacation during August, 1920. The next source of material was the herbarium of Dr. C. N. Jensen, formerly plant pathologist of the Utah Experiment Station at Logan, Utah. This material was secured from the biology department of the Brigham Young College at Logan, Utah. Besides the above two sources of material, miscellaneous collections that have been sent to the author have also been included. In some instances these miscellaneous collections are outside of Northern Utah or Southern Idaho. Where no credit is given it is the author's own collection.

The papers on the Smuts and Rusts of Utah by Prof. O. A. Garrett have been consulted in the preparation of this paper.

The author found that in Box Elder County, Utah, *Ustilago bromivora* was attacking Bromus tectorum in epiphytotic form. As a boy the author botanized in this section of the State without seeing this smut. In August, 1920, however, he found hundreds of acres infected with this smut with an average infection of from 98 per cent to 99 per cent.

SMUTS

TILLETIA ASPERIFOLIA El. & Ev.; Jour. Myc. 3: 55. 1887

On *Sporobolus asperifola* (Ness. & Mey.) Thurb. At corner of 3d North Street and 2d East Street, Logan, Cache County, Utah, August 3, 1920 (98 per cent infection); a quarter mile north of Oregon Short Line Railroad depot, Logan, Cache County, Utah, August 4, 1920 (98 per cent infection); West of Logan, Cache County, Utah, on Oregon Short Line Railroad, August 4, 1920 (85 per cent infection); near Utah-Idaho Central Railroad, Five Points, Weber County, Utah, August 14, 1920 (98 per cent infection); one mile south of Brigham City, Box Elder County, Utah, August 16, 1920 (75 per cent infection); Perry, Box Elder County, Utah, August 18, 1920 (infection only a trace).

TILLETIA FOETANS (B. & C.) Trel. Par. Fungi, Wisc. 35. 1884

On *Triticum* sp. (cultivated wheat); Beaver, Beaver County, Utah, August 21, 1918 (H. A. Christiánsen); Monticella, San Juan County, Utah, September 1918 (C. O. Stott); Kanab, Kane County, Utah, August 1918 (Hugh Hurst); Cedar City, Iron County, Utah, September 1918 (Alma Esplin); Aberdeen, Bingham County, Idaho, September 8, 1918.

TILLETIA TRITICI (Bjerk.) Wint.; Rab, Kryp. Fl. 1: 110. 1881

On *Triticum* sp. (cultivated wheat), Loa, Wayne County, Utah, September, 1918 (A. E. Smith); North Logan, Cache County, Utah, August 5, 1920; American Falls, Power County, Idaho, September 9, 1918; Rockland, Power County, Idaho, September 9, 1918; Winchester, Lewis County, Idaho, August 28, 1918.

USTILAGO BROMIVORA (Tul.) Fisch. de Waldh. Bull. Soc. Nat. Mosc. 40[1]: 252. 1867

On *Bromus marginatus* Nees., Mountain south of canyon road, Logan, Cache County, Utah, August 10, 1912 (C. N. Jensen, No. 238).

On *Bromus tectorum* L., Utah Agricultural College Campus, Logan, Cache County, Utah (85 per cent infection; Zundel & Richards) August 3, 1920; Utah Agricultural College Campus, main entrance, Logan, Cache County, Utah, August 3, 1920 (75 per cent infection); mouth of Logan Canyon, Cache County, Utah, August 4, 1920 (20 per cent infection); one mile up Logan Canyon, Cache County, Utah, August 4, 1920 (90 per cent infection); North Logan, Cache County, Utah, August 5, 1920 (4 per cent infection); Logan Canyon at Birch Glen, Cache County, Utah, August 7, 1920 (50 per cent infection); Logan Canyon at Rick's Spring, Cache County, Utah, August 7, 1920 (50 per cent infection); Ideal Beach on Bear Lake, Rich County, Utah, August 7 and 8, 1920 (3 per cent infection); West of Newton, Cache County, Utah, August 11, 1920 (30 per cent infection); Clarkston, Cache County, Utah, August 11, 1920 (15 per cent infection); Wandamere Park, Salt Lake City, Salt Lake County, Utah, August 13, 1920 (90 per cent infection); University of Utah Campus, Salt Lake City, Salt Lake County, Utah, August 13, 1920 (98 per cent infection); Lagoon Resort, Farmington, Davis County, Utah, August 14, 1920 (8 per cent infection); Five Points, Weber County, Utah (less than 1 per cent infection); Reservoir Hill, Brigham City, Box Elder County, Utah, August 16, 1920 (80 per cent to 99 per cent infection); South on Utah Idaho Central Railroad, Brigham City, Box Elder County, Utah, August 16, 1920 (85 per cent infection); Box Elder Creek, North of Brigham City, Box Elder County, Utah, August 17, 1920 (95 per cent infection); Perry, Box Elder County, Utah, August 18, 1920 (8 per cent infection); Fish Haven, Bear Lake County, Idaho, August 8, 1920 (2 per cent to 99 per cent infection); Tyhee, Bannock County, Idaho, August 19, 1920 (trace of infection); 1014 W. Fremont Street, Pocatello, Bannock County, Idaho, August 20, 1920 (15 per cent infection); Hills East of Pocatello, Bannock County, Idaho, August 20, 1920 (10 per cent infection).

USTILAGO HORDEI (Pers.) Kel. & Swing., Ann. Rep. Kans. Agr. Exp. Sta. **2**: 268. 1890

On *Hordeum* sp. cult., Beaver, Beaver County, Utah (Christiansen).

USTILAGO LORENTZIANA Thum. Flora **63**: 30. 1880

On *Hordeum jubatum* L. Logan, Cache County, Utah, August 5, 1912 (Jensen No. 220); Beaver, Beaver County, Utah, August, 1917 (Christiansen); Logan, Cache County, Utah, August 3, 1920 (90 per cent infection); Logan Canyon, Cache County, Utah, August 7, 1920 (5 per cent infection); Ideal Beach near South end of Bear Lake, Rich County, Utah, August 8, 1920 (30 per cent infection); Bloomington, Bear Lake County, Idaho, August 8, 1920 (8 per cent infection); Tyhee, Bannock County, Idaho, August 19, 1920 (trace of infection); East Halliday Street, Pocatello, Bannock County, Idaho, August 20, 1920 (3 per cent infection); near subway, O. S. L. R. R., Pocatello, Bannock County, Idaho (25 per cent infection).

USTILAGO LONGISSIMA (Snow.) Tul. Ann. Sci. Nat. III, **7**: 76. 1847

On leaves of *Glycera grandis* Wats.—Banks of Logan River, West of Logan, Cache County, Utah, August 17, 1912 (Jensen No. 251).

USTILAGO MACROSPORA Desmaz. Pl. Crypt. II. 1727. 1850.

On leaves of *Elymus canadensis* L., Oregon Short Line Railroad West of Logan, Cache County, Utah, August 17, 1912 (Jensen No. 250).

USTILAGO TRITICI (Pers.) Rostr. Overs. K: Danske Vid. Selsk. Forh. **1890**: 15 Mch, 1890

On *Triticum* sp. (cultivated wheat) Greenville, Cache County, Utah, June 17, 1918; Beaver, Beaver County, Utah, August, 1918 (Christiansen).

RUSTS

AECIDIUM ABUNDANS Pk. Bot. Gaz. **3**: 34. 1878

On *Symphoricarpus* sp.—Mountains South of Canyon Road, Logan, Cache County, Utah, August 10, 1912 (Jensen No. 237).

AECIDIUM PHALARIS Pk.

On *Phalaris leucophylla*, Torr. Logan Canyon, Cache County, Utah, June 22, 1912 (Jensen No. 209).

GYMNOSPORANGIUM NELSONI Arth. Bull. Torr. Bot. Club **28**: 665. 1901

I. On leaves of *Amelanchier alnifolia* Nutt. Dry Canyon, Cache County, Utah, August 2, 1912 (Jensen No. 277); Logan Canyon, Cache County, Utah, August 4, 1920.

MELAMSPORA CONFLUENS (Pers.) Jack. Brook. Bot. Gard. Mem. **1**: 210. 1918

II. On *Salix* sp.—Banks of Logan River, West of Logan, Cache County, Utah, August 15, 1912 (Jensen No. 246); Logan Canyon, Cache County, Utah, August 7, 1920.

PHRAGMIDIUM AFFINE Syd. Ann. Myc. **2**: 29. 1904

I. On *Potentilla gracilis* Dougl. Logan Nursery, Logan, Cache County, Utah, June 24, 1912 (Col. Leo Merrill; Jensen No. 212).

PHRAGMIDIUM IMITANS, Arth., N. A. Flora **7**: 165. 1912

III. On *Rubus americana* (Pers.) Wint.—Forks of Logan Canyon, Cache County, Utah, August 17, 1912 (Coll. Zundel; Jensen No. 248).

II, III. On *Rubus strigosus* Michx. Forks Logan Canyon, Cache County, Utah, August 17, 1912 (coll. Zundel; Jensen No. 249); Logan Canyon, Cache County, Utah, August 7, 1920.

PHRAGMIDIUM NONTIVAGUM Arth. Torr. **9**: 128. 1898

I, II. On *Rosa* sp. Dry Canyon, Cache County, Utah, August 2, 1912 (Jensen No. 224); Logan Canyon, Cache County, Utah, August 7, 1920.

POLYTHALIS THALICTRI (Cler.) Arth. Résult. Sci. Cong. Bot. Vienne 341. 1906

On *Thalictrum* sp. Logan Canyon at Birch Glen, Cache County, Utah, August 7, 1920.

PUCCINIA ABSINTHII (Hedw. f.) DC. Fl. Fr. **6**: 56. 1815

II. On *Artemesia bigelovia* Gray, Providence Bench near Dry Canyon, Cache County, Utah, August 2, 1912 (Jensen No. 225).

II, III. On *Artemisia tridenta* Nutt, Providence Bench, near planing mill, Cache County, Utah, August 2, 1912 (Jensen No. 226). Forks of Logan Canyon, Cache County, Utah, August 19, 1912, Tony Grove, Logan Canyon, Cache County, Utah, August 8, 1920.

PUCCINIA BALSAMIORRHIZAE Pk. Bull. Torr. Bot. Club **11**: 49. 1884

On *Balsamorrhiza sagittata* (Pursh.) Nutt, Logan Canyon, Cache County, Utah, August 4, 1920.

PUCCINIA COMANDRAE Pk. Bull. Torr. Bot. Club **11**: 49. 1884

III. On *Commandra pallida* DC. Logan Canyon, Cache County, Utah, June 22, 1912 (Jensen No. 211).

PUCCINIA CARICIS (Schum.) Schröt. Krypt. Fl. Schles. **3**: 327. 1889

II. On *Carex aquatica* Wahl. Fish Hatchery West of Logan, Cache County, Utah, August 13, 1912 (Jensen No. 235).

PUCCINIA CLEMATIDIS (DC.) Lagerh. Tromso Mus. Aarsh. **17**: 47. 1895

I. On *Clematis ligusticifolia* Nutt, Logan Canyon, Cache County, Utah, August 7, 1920.

PUCCINIA INTERMIXTA Pk. Bot. Gaz. **4**: 231. 1879

On *Iva axillaris* Pursh. Perry, Box Elder County, Utah, August 18, 1920. (Det. H. S. Jackson.)

PUCCINIA JONESII Pk. Bot. Gaz. **6**: 226. 1881.

I. On *Leptotaenia multifida* Nutt. Logan Canyon, Cache County, Utah, May 16, 1912 (Jensen No. 207) and III. June 22, 1912 (Jensen No. 208).

PUCCINIA MALVACEARUM Bert. Gray's Hist. de Chile **8**: 43. 1852

On cultivated *Althea,* Logan, Cache County, Utah, June 27, 1912 (Jensen No. 221).

On *Malva rotundifolia* L. Logan, Cache County, Utah, June 25, 1912 (Jensen No. 214).

PUCCINIA POLOGONI-AMPHIBII Pers. Syn. Fung. 227. 1801

On *Polygonum hartwrightii* Gray. West of Logan, Cache County, Utah, August 17, 1912 (Jensen No. 242). Det. J. C. Arthur.

PUCCINIA PROCERA Diet. Erythea **1**: 249. 1893

II, III. On *Elymus* sp. Logan Canyon, Cache County, Utah, August 7, 1920.

PUCCINIA TARAXACI (Reb.) Plowr. Brit. Ured. & Ustil. 186. 1889

II. On *Taraxacum officinale* L. Logan, Cache County, Utah, July 2, 1912 (Jensen No. 218).

PUCCINIA VERATRI Duby, Bot. Gall. **2**: 890. 1830

I. On *Epilobium adenocaulon* Hausskn. West of Logan, Cache County, Utah, August 17, 1912 (Jensen No. 240).

UROMYCES ERIOGONI El. & Hark. Bull. Calif. Acad. **1**: 29. 1884

II, III. On *Eryogonum* sp. Foothills, Logan, Cache County, Utah, August 10, 1912 (Jensen No. 236).

UROMYCES GLYCYRRHIZAE (Rab.) Magn. Ber. der. Deutsch. Bot. Gesell. **8**: 383. 1890

On *Glycyrrhiza lepidota* Nutt. Logan Canyon, Cache County, Utah, June 22, 1912 (Jensen No. 215); Clarkston, Cache County, Utah, August 12, 1920.

UROMYCES HEDYSARI-OBSCURI (DC.) Wint. Rabenh. Krypt. Fl. **1**: 152. 1884

I, II. On *Hedysarum pabulare* A. Nels. Providence Bench, Cache County, Utah, August 2, 1912 (Jensen No. 223).

UROMYCES PROEMINENS (DC.) Pas. Fl. Franc. **2**: 235. 1805; Rabenh. Krypt. Fl. Europ. 1795. 1874

On *Euphorbia dentate* Michx. Perry, Box Elder County, Utah, August 18, 1920 (Det. H. S. Jackson).

UROPHYXIS SANGUINEA (Pk.) Arth. N. Am. Fl. **7**: 155. 1907

On *Berberis aquifolium* Pursh. Logan Canyon at Birch Glen, Cache County, Utah, August 7, 1920.

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NEW OR NOTEWORTHY GEOGLOSSACEAE

Elias J. Durand

Since the publication of the writer's monograph of the Geoglossaceae of North America, in 1908, numerous specimens have been collected, or have been received from correspondents in various parts of the country, which have thrown additional light on certain little known forms. Authentic specimens of several species previously known only by description have also become available, which have, in one or two instances, materially modified the views expressed in the monograph, or have cleared up certain points at that time doubtful. The most valuable collection examined is one of 45 numbers, made by Mr. W. H. Long, in Maryland and Virginia, in 1910.

Geoglossum intermedium Durand

Virginia: Great Falls and Cherrydale, Sept., 1910, W. H. Long nos. 2236, 2251 and 2269 (D).

The three collections by Mr. Long agree well with the two previous ones from New York and Ontario, and abundantly prove the validity of the species.

Geoglossum pumilum Winter, Grev. 15: 91. 1886

Ascomata very small, 0.5–2 cm. high, slender, black; ascigerous portion distinct from the stem, clavate-elliptic to oblong-spherical, 1.5–3 mm. long, 1–2 mm. thick when dry, rounded above; stem very slender, brownish black, squamulose, especially above, 0.5 mm. thick when dry. Asci clavate, stout, 185–200 × 20–25 μ. Spores 8, fascicled in the ascus, clavate-cylindric, tapering each way from above the middle, 15-septate, 104–125 × 6 μ (majority 110–115 μ), deeply colored. Paraphyses longer than the asci, pale brown above, nearly hyaline below, the distal end stout, clavate, rather remotely septate, usually nearly straight but sometimes strongly curved, inclined to be constricted at the septa, 8–12 μ thick.

On soil, Cherrydale, Va., 17 Sept., 1910, W. H. Long no. 2248 (D); Bermuda, Nov.–Dec., 1912, Britton, Brown and Seaver no. 1364 (NY).

This interesting addition to the geoglossaceous flora of North America was first described by Winter from Brazil. It is one of the few known species with 15-septate spores. It is closely allied to *G. pygmaeum* Ger., from which it differs in its shorter spores, and especially in its more robust, longer, remotely septate paraphyses. I have not seen Winter's type, so that the identification depends upon the description only. Only two plants from each of the above mentioned collections have been seen.

MICROGLOSSUM LONGISPORUM Durand

On the ground, Cherrydale, Va., 10 Sept., 1910, W. H. Long (D).

This agrees in all respects with the previous collections from New York, North Carolina and Michigan.

MITRULA MUSCICOLA E. Henn.

On wet moss close to the water's edge, Lake Agnes, Alberta, 11 Aug., 1915, Durand n. 10413.

The following notes were made from the fresh material:

Ascomata 1–1.5 cm. high, entirely pale cinnamon-brown with a tint of tan; stem slender, terete, smooth, 0.5–1 mm. thick; ascigerous portion abruptly distinct from the stem from which it is slightly free below, hemispherical to oblong-ovate in shape, even, or irregularly furrowed, or, in extreme cases, cerebriform, 2–3 mm. wide and high, slightly darker than the stem.

This species is doubtfully distinct from *M. gracilis* Karst., previuosly reported from Labrador and Newfoundland, and more recently found in quantity in Colorado by Seaver. I searched for moss-inhabiting Mitrulas carefully but in vain at various points along the Alaskan coast as far north as Skagway.

Trichoglossum confusum Durand n. sp.

T. Rehmianum (P. Henn.) Durand, Ann. Myc. **6**: 439. *f. 93, 168.* 1908.

Ascomata solitaria, exsiccata 1.5–2.5 cm. alta; clavula obovata; stipes teres, 1–2 cm. longa, 1–1.5 mm. crassa, hirsuta; cystidia acicularia ascos parve superantia. Asci clavati, apice rotundati, 175 × 12 μ; sporidia 8, multiseriata, cylindraceo-clavata, fuliginea, primum 3- demum 7-septata, 55–73 × 4–5 μ (plurima 60–68 μ); paraphyses pallide brunneae, sursum leniter incrassatae, rectae vel curvatae.

Ad terram, Blowing Rock, N. Car., 1901, Durand n. 1934.

In the Monograph, p. 439, this collection was referred with some hesitation to *Geoglossum Rehmianum* P. Henn., a Brazilian species of which no authentic specimens had been seen, so that the determination was on the basis of description only. More recently, however, through the courtesy of Dr. G. Lindau, the writer has been able to examine a portion of the original type of *G. Rehmianum* from St. Catharina, Brazil (Ule n. 1564), and thus to settle its relationship to the Carolinian plant. In the Brazilian plant the spores are nearly cylindrical, are narrowed toward the lower end only, and measure 78–103 × 5 μ (the majority 90–95 μ), instead of 60–65 μ as indicated in the original description. The paraphyses are brownish above, and somewhat thickened and curved as in the other members of the genus. The plant from North Carolina is different, the spores being shorter, 55–73 μ (majority 60–68 μ), and distinctly clavate and narrowed both above and below the middle.

A careful study and comparison of authentic specimens has led to the conclusion that *G. Rehmianum* P. Henn. is specifically identical with *Trichoglossum Walteri* (Berk.) Durand, a species originally described from Australia, but known to occur in ten of the eastern United States. The plant from Carolina represents an undescribed species differing from *T. Farlowi* in having the spores 7-septate at maturity.

To those who would regard *T. confusum* as a 7-septate form of *T. Farlowi* it may be stated that examination of more than forty collections of the latter from twelve states has failed to disclose a single 7-septate spore. In *T. confusum* the majority are 7-septate, those with a lesser number being plainly immature.

TRICHOGLOSSUM HIRSUTUM f. BRAZILIENSE P. Henn.

In the original description of *T. hirsutum* f. *variabile* (Monograph, p. 438) its possible identity with the forma *Braziliense* P. Henn., of which no specimens had been seen, was suggested. Subsequent examination of a portion of the type of the latter from Goyaz, Brazil (Ule n. 2027), preserved at Berlin, shows the spores to be regularly 15-septate, 138–160 μ long, tapering each way from above the middle, instead of 12–14-septate as stated in the original description. It is, therefore, typical *T. hirsutum*, quite different from forma *variabile*.

Trichoglossum Wrightii Durand

Trichoglossum hirsutum forma *Wrightii* Durand, Ann. Myc. 6: 438. *f. 83, 174.* 1908.

Ascomata clavate, black, velvety, with the numerous, black cysditia, variable in size; ascigerous portion irregular, occupying about ⅓ the total length. Asci clavate-cylindric, 250–265 × 20–25 μ. Cystidia black, acute, projecting only slightly beyond the hymenium. Spores 8, fasciculate, 105–145 × 7 μ, brown, clavate, broadest above the middle, mostly 8–9-septate, rarely 5-, 6-, or 7-septate, stout. Paraphyses cylindric, septate, pale brown above, only slightly thickened and strongly curved.

Cuba: Wright (H).

Bermuda: Brown, Britton and Seaver, no. 1404 (D).

In the Monograph this species was described as a form of *T. hirsutum*, from two Cuban specimens in the herbarium of Harvard University. A third collection, from Bermuda, has convinced me of the correctness of the opinion previously expressed, that it would prove to be a distinct species. The spores resemble those of *T. velutipes*, but there are eight in each ascus.

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NOTES AND BRIEF ARTICLES

[*Unsigned notes are by the editor*]

Readers of MYCOLOGIA are invited to contribute to this department personal news items and notes or brief articles of interest to mycologists in general. Manuscripts should be submitted before the middle of the month preceding the month in which this publication is issued.

Dr. R. A. Jehle, formerly extension plant pathologist for the North Carolina State College of Agriculture, has accepted a similar position with the College of Agriculture of the University of Maryland, succeeding Prof. C. E. Temple, who has become professor of plant pathology in the University of Maryland.

Mr. M. A. Carleton, formerly in charge of the Office of Cereal Investigations, United States Department of Agriculture, and recently plant pathologist for the United States Grain Corporation, is now employed as plant pathologist for the United Fruit Company, with headquarters at Bocas del Toro, Panama.

Mr. R. W. Goss, formerly assistant pathologist in cereal disease investigations, Bureau of Plant Industry, with headquarters at Madison, Wisconsin, has become assistant plant pathologist at the Nebraska Agricultural Experiment Station, where he will take up the study of the potato *Fusarium* problems of that region.

Dr. O. F. Burger, formerly pathologist at the California Agricultural Experiment Station, Riverside, and recently engaged in the investigation of fruit and truck crop diseases in the United States Bureau of Plant Industry, has become head pathologist at the Florida Agricultural Experiment Station, Gainesville. He will give special attention to the study of transportation diseases of truck and citrus crops.

Miss Wakefield, the well-known mycologist of Kew Gardens, England, arrived in New York on March 10, after spending the winter collecting in the British West Indies. On March 19, she left for a tour through parts of the eastern United States, and sailed for England on May 14. Her chief interest at the Garden was the large collection of polypores from the American tropics.

Nodule bacteria of leguminous plants form the subject of an article by Löhnis and Hansen in the *Journal of Agricultural Research* for January 3, 1921. *Bacillus radicicola* and *B. radiobacter* are the species chiefly discussed, the latter being easily distinguished from the former by its brown growth on potato.

A descriptive list of Brazilian gill-fungi, by J. Rick, appeared in *Broteria* **18**: 48–63. 1920. Of the 106 species treated, a number are proposed as new in various genera, but the author feels that many of the new ones are identical with European species!

Sclerotinia minor is the cause of a decay in lettuce, celery, and other crops, according to Ivan C. Jagger, who published an account of this new fungus in the *Journal of Agricultural Research* for November 15, 1920. The species is known from Massachusetts, New York, Pennsylvania, and Florida.

A specimen of *Pycnoporus cinnabarinus* (Jacq.) P. Karst. has recently been received from George L. Zundel, who collected it March 9, 1921, on birch, at Arden, Stevens County, Washington. Although reported by Harkness as occurring on oak in California, this is the first time I have seen this species from the Pacific coast.

A list of the fungi of the Malay Peninsula, compiled by J. F. Chipp, appeared in the *Gardens Bulletin, Straits Settlements* for January, 1921. The list is prefaced by remarks on our knowledge of Malayan fungi and the preservation of fungous specimens in the tropics. Following it is a bibliography, and an index to fungi found on the Malay Peninsula and to their hosts.

The way in which smut infects sugar-cane was described by Dastur in the *Annals of Botany* for July, 1920. It occurs only in young buds and not through the cut ends of setts. The sporidia on germinating penetrate the young, thin-walled scale hairs, and within two months a bud thus infected may produce a spore-bearing shoot. Diseased sets will, of course, grow into diseased shoots when planted.

The mildness of the winter season around Fayetteville, Arkansas, has brought forth some unseasonable growths both among the seed- and the spore-bearing plants. It may be of interest to note that *Pluteus cervinus* Fr., a common mushroom of this region, usually found from May until October, was collected on February 8. A number of good-sized, fresh specimens were obtained, some of the pilei measuring 10 centimeters in diameter. The spores appeared normal in size, shape, and color.—H. R. ROSEN.

Cranberry diseases and their control are discussed in a popular way by C. L. Shear in *Farmers' Bulletin* 1081 of the United States Department of Agriculture. Of the dozen or more diseases included, "early-rot," caused by *Guignardia Vaccinii* Shear, heads the list for destructiveness. Spraying with Bordeaux mixture will control most of these diseases, while large losses due to smothering can be avoided by proper methods and conditions of picking, storing, and handling the fruit.

Notes on the Thelephoraceae of North Carolina, by W. C. Coker, in the *Journal of the Elisha Mitchell Scientific Society* for February, 1921, comprise 51 pages of descriptive matter and 22 handsome plates made from photographs and drawings. *Aleurodiscus macrodens* is described as new. This paper, although dealing only with Carolina species, is an excellent introduction to the family for students in any part of the country.

Some observations on the life-history of *Nectria galligena* Bres., by Dorothy M. Cayley, appeared in the *Annals of Botany*

for January, 1921. This fungus will complete its life-history on media containing starch or a derivative of starch with 1 per cent glycerin. Besides the three known forms of spores, the author discovers a fourth form, a two-celled multinucleate spore. No conclusive evidence was found of the occurrence of pycnidia in the life-history of this species.

Fomes geotropus, a large polypore found frequently at the base of living trunks of various trees in the Gulf states and many parts of tropical America, causing serious decay, has often been confused with *Fomes ulmarius,* which it *greatly* resembles. Having studied the two species carefully in the field, I must consider them of different origin and distribution so far as the present era of the earth's history is concerned. Let those who regard them identical explain why *F. ulmarius* is common on elm trees in England, for example, and never found on similar trees in the United States north of the Gulf region.

The *Torrey Bulletin* for January, 1921, contains two important articles on fungi; the first by H. E. Thomas on "The relation of the health of the host and other factors to infection of *Apium graveolens* by *Septoria Apii,*" and the second by Prof. Arthur on "New species of Uredineae." The latter contains descriptions of two new genera, *Lipospora* Arthur and *Teleutospora* Arthur & Bisby; 5 new species, *Puccinia pacifica* Blasdale, *P. irrequisita* Jackson, *P. additicia* Jackson & Holway, *Uromyces coordinatus* Arthur, *Ravenelia havanensis* Arthur, and *Lipospora tucsonensis* Arthur; and a large number of new combinations.

An imperial bureau of mycology, with Mr. E. J. Butler as director, has been established at Kew Gardens, England, for the encouragement and co-ordination of work on the diseases of plants caused by fungi in the British Overseas Dominions and Colonies. One of its functions will be to lend out to workers without good library facilities original papers on mycology and

plant pathology. For this purpose reprints, pamphlets, and bulletins are more suitable than bound volumes of periodical publications, and as these are often not available for purchase, Mr. Butler would be grateful to authors who have pamphlets or reprints to spare, if they would present one or two copies so that their work may be readily brought to the notice of isolated workers in the outlying parts of the British Empire.

A very beautifully illustrated paper by F. R. Jones and C. Drechsler on crownwart of alfalfa, caused by *Urophlyctis Alfalfae,* appeared in the *Journal of Agricultural Research* for November 15, 1920. This disease has been found to have its origin in the infection of very young buds, the foliar elements of which develop into abnormalities not involving the mature structures of root or stem. Infection appears to take place only early in the spring, becoming easily discoverable in the latter part of March or in early April in northern California. The abundant development of the disease in the regions where it now occurs is apparently associated with excessive moisture during the period when infection is taking place. Any measures which can be taken to reduce the moisture near the surface of the soil at this time should reduce the disease.

Fusarium oxysporum nicotianae is the name proposed by Johnson in the *Journal of Agricultural Research* for January 3, 1921, for a wilt disease of tobacco found in Maryland and Ohio. The conditions favoring infection with the tobacco-wilt organism are heavy soil infestation, wounded host tissue, a relatively high soil temperature (28° to 31° C.), and a susceptible variety. The White Burley is most susceptible, and the Havana Seed and Cuban varities are among the most resistant. Where the disease threatens to become serious, growers are advised not to grow tobacco on the infested soils and to avoid the danger of infested seed beds. The most hopeful means of control appears to lie in the development of strains resistant to the disease within the various susceptible varieties.

An underground gasteromycete, apparently a species of *Hysterangium,* was brought to me about the middle of February by Mr. L. Robba, who collected it with a trained truffle dog under an oak tree near White Plains, New York. The soil was not frozen hard, because of the mild weather and a layer of two or three inches of leaves, but the tiny "puffballs" were frozen and made very poor specimens when dried. The spores were rather rough, ovoid, and distinctly umber-brown under a microscope. Mr. Robba naturally thought they were truffles, but he did not notice any odor and he recalled that his dog was not particularly "interested" in the find, only scratching a little to mark the spot and then walking away. The plants were unearthed by scraping off the covering of leaves and digging about two inches into the soil. There must have been *some* odor present, otherwise the dog would not have been attracted.

What we need here in the East is an army of enthusiasts like Mr. Parks, who would take long journeys with rake and hoe and explore for underground "puffballs." A few trained truffle dogs would also be invaluable. This is a matter for mycological and botanical clubs to consider. The autumn is the best season for such work.

Mr. H. E. Parks, of San Jose, California, has been collecting a great many underground fungi during the past few years, and I have asked him to prepare a brief account of his recent work for MYCOLOGIA. During the season of 1917–1918, he reported a number of specimens from the Santa Cruz Mountains generically determined, as well as the following species: *Gautieria morchelliformis,* buried two inches in an old road-bed; *Genea Harknessii,* on the surface of clay soil under pines; *Genea Gardnerii,* under deep leaf-humus; *Pseudobaldamia magnata,* buried deep in wet soil in jungle; *Tuber candidum,* in loose soil under oak; *Elasmomyces russuloides,* under deep leaf-humus; and *Geopora Harknessii,* on the surface of clay soil under pines.

In January of the present year, he collected under a single isolated oak (*Q. agrifolia*), in an area about ten feet square, 7 genera and 11 species of hypogaeous fungi. The genera were:

Melanogaster, Hysterangium, Elasmomyces, Hydnangium, Hymenogaster, Genea, and *Tuber.* The determined species were *E. russuloides, G. Gardnerii,* and *T. californicum.*

In February, Mr. Parks sent me specimens of the following boletes : *Ceriomyces flaviporus, C. tomentipes, C. viscidus, C. communis, C. subtomentosus,* and *Suillellus Eastwoodiae.* In the same package was a new *Poria,* which I have named in his honor.

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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL GARDEN

Price, 25 cents each. See next page

No. 17. The Tylostomaceae of North America, by V. S. White.

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MYCOLOGIA

VOL. XIII JULY–SEPTEMBER, 1921 NOS. 4–5

MASSACHUSETTS SPECIES OF HELVELLA

P. J. ANDERSON AND MARGUERITE G. ICKIS

(WITH PLATES 11 AND 12)

Smithsonian Institution
OCT - 8 1921
National Museum.

INTRODUCTION

Helvella is a small genus containing less than fifty species, only a small part of which occur in any one locality. They are not so common in New England but that the fungus hunter experiences a thrill of pleasure on finding one and the day is considered eminently successful if he has picked up more than two or three species. In view of the small number of known species he anticipates no great difficulty or labor in identifying his collections, but soon finds himself confronted with these discouraging conditions: (1) there is no one place where the descriptions of the known American species are brought together, (2) there is not even a list of the species which occur in America later than that of Underwood (1896) and he gives no keys, descriptions, or figures, (3) the heterogeneous lists scattered through Saccardo's Sylloge Fungorum include many species which have been removed from the genus, many others known to be synonyms; the descriptions are very brief and many of them unsatisfactory even to one quite familiar with the Latin tongue, (4) there is marked confusion in regard both to the delimitation of the genus and more especially of the species, (5) the literature is scattered, contradictory, and much of it not readily accessible, (6) lists other than those of Saccardo are only local, (7) exsiccati speci-

[Mycologia for May (13: 129–199) was issued June 25, 1921]

mens are of little value in identification because most of the specific characters are lost in the process of drying.

There is real need of a comprehensive monograph of all the North American forms. The writers have neither time nor means at present to treat the subject so broadly, but as a contribution toward the accomplishment of such a work they have made a study of the species which occur in their state, the results of which are set forth in this paper. They have, however, included not only the species which they and others have collected in Massachusetts, but also have added in the key and descriptions all other species which have been reported from the northeastern states, in order that the paper might be more widely useful and also because species which occur in neighboring states may be looked for in Massachusetts, although they have never been reported.

Species of *Helvella* are separated from each other largely on the bases of the shape, configuration, size, and color of the stripe and pileus. The spores, asci, paraphyses, and internal structure of ascomata of all the species which occur here are so nearly identical that microscopic examination of dried specimens is useless. Also, when a plant is dried, especially if pressed, it loses its shape and original size and the colors almost always change. The most valuable contribution one can make to the understanding of the species of the genus is not by making numerous collections which are filed away to receive later worthless descriptions of what they look like in the dried state and measurements of spores, etc., which are all alike. Much more valuable are careful notes, descriptions, photographs and drawings of fresh plants. Commenting on the unsatisfactory nature of dried specimens, Bresadola has well remarked that "he alone acquires a correct knowledge of these species who is able to spend the green season of the year in regions where they grow abundantly and to make comparisons between them" (Fung. Trident. p. 64. Translated). In making notes on the collections, one should describe colors by well-known color standard charts; popular descriptions of colors and shades of colors are subject to rather wide ranges of interpretation. Colored plates such as those of Boudier are especially useful.

The distinct species which occur here are comparatively few but the names which have been applied to them are numerous, confusing, and discouraging. In the present paper the writers have attempted (1) to determine according to the international rules of nomenclature what are the correct names for the species which occur here, (2) to indicate which other names are synonyms and which names apply to species which are no longer considered as belonging to this genus, (3) to present a key by which any specimen can be quickly placed in its proper species, (4) to bring together in one place the original descriptions of all of our species (or Fries' description if described before 1823), (5) to give for each species a full but concise English description, based on study of fresh specimens and study of all available literature, (6) to publish photographs of all species of which fresh specimens from which to make them have been obtained.

In addition to our own collections and exsiccati in the herbarium of the Massachusetts Agricultural College, the herbaria of Harvard University, Boston Mycological Club, New York Botanical Garden, and New York State Museum at Albany have been examined.[1] All the literature bearing on the genus, both European and American, has been carefully read.

Literature of the Genus

Linnaeus has commonly been cited as authority for the genus name *Helvella*. He first used it in its present form in the second edition of Species Plantarum (1763). In the ninth edition of his Genera Plantarum, however, Gleditsch (1753) is cited as the authority for the genus name. Gleditsch, however, in his Methodus Fungorum, called it *Elvela* and included under it various species which we now place in the Helvellales and Pezizales, Jew's ear fungus and many other foreign species, using the polynomial system of nomenclature. This use of the name to

[1] The writers are greatly indebted to Dr. R. Thaxter, of Harvard University, Dr. F. J. Seaver, of the New York Botanical Garden, Miss Jennie F. Conant, of the Boston Mycological Club, and to Dr. H. D. House, New York State Botanist, for the privilege of examining the herbaria under their care, and for many other courtesies and assistance. Dr. Seaver also kindly read the manuscript.

include a large part of the Discomycetes and various other forms was usual before the time of Linnaeus and not uncommon for many years after him. In the first editions of Flora Suecica (1745), Genera Plantarum (1737), and Species Plantarum (1753) Linnaeus spelled the name *Elvela*. In the second edition of Flora Suecica (1755), he used *Elvella*. He offers no explanation of why he twice changed the spelling of the name nor from what source he originally took it. Phillips offers this rather unsatisfactory explanation of its origin, that it was a Latin word used by Cicero to denote some kind of fungus. The etymology of the word is uncertain. All three methods of spelling it have been used by various writers but the majority since the beginning of the last century, including Persoon and Fries have used *Helvella*. Seaver, in a recent article has returned to the original spelling *Elvela*. In the present paper the orthography of Fries is followed.

At most, we owe nothing but the name to Linnaeus; he contributed nothing to our knowledge of the species included. He united all of them under the specific name *Mitra* (except *El. Pineti,* which is not a *Helvella* at all as understood by modern mycologists). One secures more information in regard to the species of the genus from the works of previous writers than from Linnaeus. Thus Michelius in 1729 had already grouped the species of *Helvella* in much the same sense as we now know them in the section Fungoidea fungiformia of his genus *Fungoides*. Each of the nine species in this section is briefly described and three of them are well illustrated. Even before the time of Michelius one finds some good descriptions by Rajus (1704), Porta (1592), Clusius (1583), and others. These fungi seem to have been subjects of considerable interest to the older botanists and hence were frequently described and figured. But in this early literature one finds them not under the genus name *Helvella,* but under *Boletus, Phallus, Fungoides, Morchella, Boleto-lichen,* etc.

During the period between the appearance of Linnaeus' Species Plantarum and the publication of Fries' Systema Mycologicum, knowledge of the genus was greatly advanced by the works of

Schaeffer, Afzelius, Persoon, Scopoli, Bulliard, Sowerby, and others who made smaller contributions. But the multiplicity of publications did not result in a harmonious system of nomenclature. The changing and interchanging of names during this period is very confusing. An examination of the synonymy which is appended under some of the older species such as *H. crispa* and *H. lacunosa* gives one some idea of the state of the nomenclature at that time.

Fries, in the second volume of his Systema Mycologicum, treated the genus fully and very clearly, and his work furnishes an excellent basis for our present taxonomy of it. In reading this book one is surprised to find how few taxonomic changes have been made in the last century. To be sure some of the species have been transferred to *Gyromitra,* which he later (1846) split off from *Helvella,* and a few others are now believed to be among closer relations in the Pezizales, but most of his species are still in the genus *Helvella* and bear the same names which he used for them. Also, no small part of the species which have been described since then could be easily referred to species which he described.

Since his time a number of species have been described from various parts of the world by various authors. European species have been well monographed by Rehm, Massee, Gillet, Phillips, et al., excellent colored plates published by Boudier, Cooke, and others. But on turning to the American literature of the genus we find very little of value. A few new species have been described by Peck and Clements—some few of which are really new, others probably merely variations of old species. Underwood published in 1896 a list of all species which had been reported from North America. A few local lists, sometimes accompanied by descriptions and figures, such as those of Hone (1904) and Burt (1899), complete the sum of American literature on the genus.

Turning now to the literature which deals with collections of *Helvella* within the state of Massachusetts we find that the full extent of our information is based on the inclusion of names of a few species in published local lists of fungi. The first of these

lists is Hitchcock's Catalogue of Plants Growing without Cultivation in the Vicinity of Amherst College published in 1829. In this list one finds (p. 61) three species of *Helvella: H. albida* Bull., *H. esculenta* Pers., and *H. mitra?* L.[2] The second one of these species is now *Gyromitra esculenta* Fr. and need not be considered here. The other two are somewhat difficult to place exactly. There is a *H. albida* Pers. (=*H. elastica* Fr.) and a *H. albida* Schaeff. (=*H. crispa* Fr.), but there seems to be no *H. albida* Bull. His third species is still more indefinite in view of the fact that Linnaeus included all the species of *Helvella* under the name *H. Mitra*. Hitchcock's list then adds little or nothing to our knowledge of what species of *Helvella* occurred in the state at that time. Charles L. Andrews presented a paper before the Boston Society of Natural History in 1856 on the fleshy fungi of Massachusetts. He included descriptions of 36 species but no *Helvellae* were mentioned. During the same year C. J. Sprague read a paper before the society, "Contributions to New England Mycology," and a second paper under the same title two years later. In his first paper he included 350 species of fungi, most, but not all, of which were collected about Boston. He mentions in this paper *Helvella* (*Peziza*) *macropus* Pers. and *Helvella lacunosa* Afz., the latter however having been collected in Maine. In his second paper he increased the number of reported fungi to 678. *Helvella crispa* Scop. and *H. Monachella* Fr. are in the second paper and one judges from the context that they were collected within the state. In 1860 Sprague gave up his study of fungi and turned over his unworked material to C. C. Frost who, in 1869, presented a list, "Further Enumeration of New England Fungi," of 262 species not mentioned in Sprague's lists. The only *Helvella* mentioned is *H. ephippium* Lev. which may or may not have been collected within the state. In 1875, Tuckerman and Frost's "Catalogue of Plants Growing without Cultivation within Thirty Miles of Amherst College" appeared. In the list of fungi, Frost included four species of *Helvella: H. crispa* Fr., *H. elastica* Bull., *H. lacunosa*

[2] The same list is repeated in his Report on the Geology, Botany and Zoölogy of Massachusetts (1833) and in his Catalogues of the Animals and Plants of Massachusetts (1835).

Afz., and *H. ephippium* Lev. It has been customary for mycological writers to speak of Frost's collections as being from Massachusetts. Frost, however, did not live in Massachusetts and most of his collections were made near his home in Brattleboro, Vt. In the first and second volumes of the bulletins of the Bussey Institute 1875–1900, Farlow published two long lists of fungi found in the vicinity of Boston. In these lists however, no species of Helvella were mentioned unless we wish to consider *Peziza macropus* Pers. as a *Helvella.* Underwood, in his paper "On the Distribution of the North American Helvellales" adds nothing to the above list except the interesting fact that he himself had collected *H. elastica* in this state. In the Peabody Museum at Salem, Massachusetts, there are a large number of water-color drawings of fungi by George E. Morris of Waltham, Mass. The locality of collection is indicated under each drawing. The species of *Helvella* which he illustrated from collections in this state were: *H. crispa, H. ephippium, H. lacunosa, H. Monachella, H. macropus,* and *H. macropus* var. *brevis* Pk. The last named variety was described by Peck (Bul. Tor. Club **29**: 74) from specimens sent to him by Morris.

SYSTEMATIC ACCOUNT

Helvella Fr. Sys. Myc. **2**: 13. 1823

Boleto-lichen Jus. Mem. Ac. Sc. Paris. 1728, p. 268.
Fungoides, Sect. *Fungoidea fungiformia* Mich. N. Pl. Gen. p. 204. 1729.
Elvela L. Gen. Pl. (Ed. I), p. 327. 1737.
Elvela L. Sp. pl. (Ed. I), p. 1180. 1753.
Elvela Gled. (pars). Meth. fung., p. 36. 1753.
Elvella L. Fl. suec. (Ed. II), p. 456. 1755.
Boletus Batt. (pars). Fung. arim. hist., p. 23. 1759.
Helvella L. Sp. pl. (Ed. II), p. 1649. 1763.
Phallus Scop. (pars). Fl. Carn. **2**: 473. 1772.
Leptopodia Boud. Bul. Soc. Myc. Fr. **1**: 99. 1885.

Fries' description of the genus. Receptaculum pileatum, centro suffultum, deflexum, subinflatum, sinuosum, subtus concavum sterile, supra margineque hymenio tectum. Hymenium laeve,

persistens. Asci fixi.—Stipes constanter praesens, cum centro receptaculi contiguus, cavus l. medulla floccosa farctus. Pileus adultus mitraeformis, compressus, lobatus, siccus, subtus pruinosus. Substantia ceraceo-membranacea.

Plants large, usually several centimeters high, stipitate and upright. Pileus thin, deflexed, attached at the center, concave below; of irregular shapes, lobed, irregularly undulate, mitriform, compressed, saddle-shaped, etc.; not typically cup-shaped or closed when young; without gyrose elevations on the upper surface; margin free or attached to the stipe on opposite sides or at several points; of a waxy membranaceous or waxy-fleshy consistency; upper surface covered by the hymenium, glabrous; lower surface sterile, glabrous, pruinose, tomentose or villose, sometimes rugulose or venose. Hypothecium and excipulum of densely interwoven hyphae passing outwardly into a pseudoparenchymatous cortex of larger cells. Stipe slender or stout; straight or irregularly undulate; smooth, lacunose or with deep longitudinal furrows separated by narrow costae, frequently entire stipe composed of costae united by their inner edges, outer edges of costae usually irregularly anastomosing; solid, stuffed or hollow; glabrous, pruinose, tomentose or villose. Asci long cylindrical or narrowly clavate, with 8 spores in a single row. Spores hyaline, continuous, ellipsoidal, smooth, 15–20 × 9–12μ in our species, with a large prominent central oil globule. Paraphyses slender, straight, septate, sometimes branching, enlarging upward to 2–3 times the diameter of the base, hyaline or tinged with brown.

Solitary or gregarious, subfleshy fungi, without distinctive taste or odor, autumnal, in the damp woods on the ground or wet rotten stumps or logs. Most of them are said to be edible.

The genus as originally delimited by Fries (1823) falls naturally into three sections, as follows:

Stipe longitudinally sulcate-costate (fluted).	*Helvella* proper
Stipe smooth, or at most somewhat lacunose or irregular.	
Small plants with slender stipes.	*Leptopodia* Boud.
Large plants with thick stipes.	*Gyromitra* Fries

The first section is the oldest and best known and is typified by the common species *H. crispa* and *H. lacunosa*. These species have never been referred to any other genus since the time of Fries.

The second section includes *H. elastica, H. atra, H. ephippium* and *H. adhaerens*. It includes the species on the doubtful line

between *Helvella* and *Macropodia.* Boudier (1885) separated these species from *Helvella* and established the genus *Leptopodia* with *H. elastica* as the type.

The third section includes *H. esculenta, H. infula,* and other species which are now commonly referred to the genus *Gyromitra.* Their characters tend toward those of *Morchella.* Fries considered *H. esculenta* so distinct from the other species that he made it the basis of a separate genus *Gyromitra* which he characterized thus: "*Discus bullato-inflatus, costis elevatis gyrosus*" (Sum. veg. Scan. 346. 1846). He left *H. infula,* however, in the genus *Helvella.* This species seems more closely related to *H. esculenta* than to the other Helvellae, and Rehm has therefore removed it also to *Gyromitra.* Seaver considers it identical with *G. esculenta* and unites the two under the name *Elvela infula* Schaeff. Pending further study of fresh material in the field, the writers have not considered this or other species of *Gyomitra* in this paper. *G. brunnea* Und. is the only other species of that genus which they have found in Massachusetts. They hope to discuss *Gyromitra* in a future paper.

KEY TO SPECIES OF HELVELLA IN THE NORTHEASTERN STATES

I. Stipe longitudinally sulcate-costate (fluted).
  1. Plants light-colored (white, cream-colored to light-buff, or with bright-yellow hymenial surface), margin upturned, usually free. *H. crispa.*
  1. Plants some shade of gray, brown or black.
    2. Pileus venose below with prominent branching veins radiating from the stipe. *H. Queletiana.*
    2. Pileus not prominently venose below.
      3. Pileus more or less saddle-shaped, compressed, firm, margin permanently adnate with the stipe. *H. lacunosa*
      3. Pileus irregularly agariciform (only rarely saddle-shaped), less firm, margin usually found free. *H. palustris.*
      3. Pileus cup-shaped (pezizoid), stipe and lower surface of plieus black velvety. *H. nigra*

II. Stipe smooth; somewhat lacunose at times but never sulcate-costate.
  1. Margin of pileus always free.
    2. Pileus more or less cup-shaped (margin upturned), lower surface and stipe villose with brown moniliform hairs.
      3. Spores blunt-ellipsoid, 15–18μ long. *H. ephippium.*
      3. Spores ellipsoid-fusiform, 18–25μ long. *Macropodia macropus*

2. Pileus not cup-shaped, stipe white or very light-colored, not villose. *H. elastica.*

1. Margin of pileus adnate with stipe.

2. Entire plant whitish or smoky-white (may become brown in age or in drying). *H. adhaerens.*

2. Smoke-gray to fuscous-black, stipe very dark. *H. atra.*

2. Pileus brown, stipe white. Larger than the two preceding species. *H. Monachella* (?)

1. HELVELLA CRISPA Fr. Sys. Myc. **2**: 14. 1823

Elvella pallida Schaeff. Fung. **3**: *t. 282.* 1770.

Phallus crispus Scop. Fl. Carn. **2**: 475. 1772.

Phallus lobatus Batsch. Elenchus fung. p. 129. 1783.

H. lacunosa var. *pallida* Afz. Kongl. Vet.-Akad. nya Handl. **4**: 303. 1783.

H. alba Berg. Phyt. 1. *t. 145.*

H. nivea Schrad. Journ. Bot. **2**: 66.

H. mitra var. *alba* Bull. Champ. p. 298. 1786.

H. mitra var. *fulva* Bull. Champ. p. 298. *t. 466.* 1789.

H. mitra Sow. Col. Fig. Brit. Fung. *t. 39.* 1797.

H. leucophaea Pers. Obs. Myc. **2**: 19. 1799.

H. leucophaea Tratt. Ess. Schw., p. 163. 1809.

Fries' description. Pileo deflexo lobato liberato crispo pallido, stipite fistuloso costato-lacunoso.

Solitaria, magna, 3–5 unc. alta, primo obtutu glabra. Stipes niveus exsiccatione flavescens, validus, deorsum ventricosus, totus sulcato-costatus lacunosusque, costis planis fistulosis, unde stipes dissectus e tubulis pluribus discretis componitur. Pileus deflexus, inflatus lobatus, margine primo stipiti adnato, mox libero undulato laciniato-contorto & crispato.

Pileus drooping, lobed, irregularly wrinkled and contorted above, margin at first slightly adnate to the stipe but soon free, extreme margin curled upward in all of our specimens, fragile and easily splitting, white, cream color, light-buff or yellow, 1.5–7 cm. in diameter, glabrous, smooth or sometimes rugulose beneath. Stipe stout, glabrous or pruinose, white or colored like pileus, ventricose toward the base and attenuate upward, longitudinally sulcate-costate, lacunose by the irregular anastomosing of the outer margins of the costae, whole stipe apparently formed by the edgewise anastomosing of flat plates enclosing tubes in the center and furrows on the surface, 2–10 cm. tall, .8–2 cm.

diam. Asci cylindrical, 250–300 × 15–18μ. Spores ellipsoidal, smooth, hyaline, with large central oil drop, 16–19 × 9–12μ. Paraphyses straight, slender, enlarging upward, hyaline, slightly longer than the asci. (*Pl. 11, fig. 1.*)

Plants usually solitary, in dense wet woods, especially along streams, on the ground, leaf-mold, or sometimes decayed logs or stumps. Common in autumn.

The pilei of all the specimens which the writers have collected about Amherst are cream-color, light-buff, or warm-buff. Plants exhibiting shades of pink or red are said to be common in Europe. On the basis of color Fries (l. c.) enumerates three forms; (a) *alba, pallescens,* (b) *incarnata,* (c) *lutescens.* Similarly Massee (1895) gives:

"Forma *alba.* Pileus whitish..
Forma *Grevillei.* Under surface of pileus reddish; stem white.
Forma *incarnata.* Pileus and stem flesh color.
Forma *fulva.* Pileus yellowish to tawny."

In the exsiccati the stipes become light-buff or warm-buff but the hymenial surface becomes much darker, cinnamon, bay, ochraceous-tawny or ochraceous-buff in specimens we have compared with Ridgway's Color Standards.

The size of the plants is an extremely variable character; a condition which is true of all the species of *Helvella* which we have studied. Our specimens have usually been small, rarely exceeding 4–5 cm. in height, and we have frequently found diminutive forms less than 1.5 cm. high. Hone (1904) describes the Minnesota specimens as up to 10 cm. in height and the stipe up to 5 cm. in diameter. In the Harvard herbarium there are specimens which measure up to 8 cm. tall; in the fresh condition they must have been fully as large as those from Minnesota. Most of the specimens which one finds have the pileus entirely free on the margin. We do not find the costae hollow in our small specimens as described by Fries and others.

Massachusetts Collections: Boston 1858 (Sprague); Waltham, Oct. 1901 (Morris); Roslindale, Oct. 1901 (W. R. Hudson), Bost. Myc. Herb.; Williamstown, Sept. 1901 (Farlow), in Harv. Herb.; Amherst, Sept. and Oct. 1919 and 1920 (Ickis & Anderson) M. A. C. Herb. 2643, 2715, 2732, 2822. Frost's col-

lections are not listed here or later because of the uncertainty of the locality. The number of exsiccati in the various herbaria indicate that this species is common throughout the eastern states.

2. HELVELLA LACUNOSA Fr. Sys. Myc. **2**: 15. 1823

Boletus leucophaeus Batt. Arim. hist., p. 25. 1755.
Elvela Mitra Schaeff. Fung. *t. 154.* 1763.
Elvela monacella Schaeff. Fung. *t. 162.* Index, p. 106. 1763.
Helvella lacunosa Afz. Kong. Vet.-Akad. Handl. **4**: 303. 1783.
H. sulcata Afz. Kongl. Vet.-Ak. Handl. **4**: 305. 1783.
H. sulcata Willd. Fungi. berolin., p. 398. 1787.
H. sulcata Fr. Sys. Myc. **2**: 15. 1823.
H. sulcata Afz. var. *cinerea* Bres. Fung. Trid., p. 41. 1881.
H. sulcata Afz. var. *minor* Clem. Bot. Sur. Nebr. **4**: 8. 1896.

Fries' description. H. lacunosa, pileo inflato lobato cinereo-nigro, lobis deflexis adnatis, stipite fistuloso costato-lacunoso. Ab antecedente (H. crispa), pro cujus varietate facile sumi posset, differet pileo magis regulari, 2–4-lobo, vix laciniato, lobis serius liberatis & praecipue colore. Statura plerumque minor, subinde tamen aeque procera occurrit s. *Helvella mitra g. pratensis* Alb. & Schwein. consp. p. 298. Quamvis igitur characteres acuti desint, in natura constans; etiam in cibariis vilior.

H. sulcata, pileo deflexo lobato adnato, stipite farcto costis aequalibus sulcat. Solitaria, raro gregaria, tota glabra, certe a priori diversa. Stipes farctus, 2 unc. longus, 4–5 lin. crassus, teres, sursum attenuatus, sulcis longitudinalibus profundis exartus, costis tenuibus solodis, nec lacunoso-fistulosis ut in praecedentibus. Pileus deflexus aequaliter 2–3-lobus, compressus, laevis, exsiccatus obscurior, latere interiori stipiti adnatus.

Pileus lobed, saddle-shaped, compressed or irregular, lobes deflexed and adnate with the stipe, firm, varying in color from smoke-gray to almost black, 1.5–5 cm. broad, glabrous, smooth, or lower surface rugulose. Stipe even or attenuate upward or downward, sometimes ventricose, smoke-gray, sulcate-costate, with the costae sometimes anastomosing by their outer margins, sometimes free throughout the extent of the stipe, costae solid in our specimens but said to be sometimes hollow, stipe formed as in *H. crispa,* 1.5–10 cm. in height by 0.5–2 cm. in diameter. Asci cylindrical, 250–350 × 15–20μ. Spores ellipsoidal, hyaline, smooth, with large central oil drop and some very much smaller ones, 15–19 × 10–12μ. Paraphyses slender, septate, enlarging upward, hyaline or brown tinted. (*Pl. 11, figs. 2, 3, 4, 5.*)

Solitary or gregarious, on the ground, or frequently on wet, rotten logs and stumps in the woods. Not uncommon in autumn.

This species varies greatly in size, shape, and color with the locality and conditions of development. Such variations have resulted in the establishment of a number of species and varieties, as indicated by the synonyms listed above, but the lack of good constant specific characters and the occurrence of intergrading specimens indicate that they might better be considered merely as variable forms of this rather broad species. The writers have followed Rehm (1896), Massee (1895), and others in uniting *H. sulcata* Afz. with this species. Fries considers them as separate species and places in *H. sulcata* the forms with stuffed stipes and solid costae which do not anastomose, while in *H. lacunosa* he places those with hollow stipes and hollow costae which sometimes anastomose. Later writers have also found that the latter is the larger species, e.g., Boudier (1905) gives the height of *H. lacunosa* as 5–12 cm. and that of *H. sulcata* as 3–7 cm., also adding that the stipe of *H. sulcata* is not ventricose at the base and the spores are a little smaller. Specimens collected about Amherst have rarely been over 5–6 cm. in height, the costae are solid and the stipes not hollow. They agree, therefore, more nearly with the descriptions of *H. sulcata.* But in the anastomosing of the costae they resemble *H. lacunosa* Fr. In view of the pronounced tendency to variation in stature which is exhibited by various species of *Helvella,* size, unless very extreme, would hardly seem to be a safe specific character. As for the distinction based on the solid or hollow condition of the costae, we have previously noted that both conditions seem to exist in *H. crispa* but no writer has attempted to split the latter into two species on this basis. In our specimens interior tubes have been found only where the furrows on the surface have been converted into tubes by the anastomosing of the outer edges of the costae.

Our specimens have uniformly had smoke-gray stipes and smoke-gray to fuscous pilei, which become darker as they become older or dry out. Fries lists under *H. lacunosa* a form *major* with white stipe and form minor with blackish stipe. Also

under *H. sulcata,* he has form *fusca* with black pileus, brown stipe becoming ash-gray on drying and form *cinerea* which is entirely ash-gray. Boudier describes *H. lacunosa* as having the pileus black both above and below and the stipe somewhat lighter, while in *H. sulcata* it is blackish or cinereous with a paler stipe. Willdenow mentions a variety of *H. sulcata* which is entirely white. One concludes after reading the descriptions of the various authors that the shade of color is extremely variable but it is agreed by all that it can be readily distinguished from *H. crispa* by its sombre hues. Also in this species we do not find the margin curled upward as in *H. crispa,* and in our collections the pileus has never been found entirely free from the costae.

Massachusetts Collections: Sprague (1856), Frost (1875), and Underwood (1896) have included this species in their lists of New England fungi but the localities from which they were collected are uncertain. Waltham, Aug. 1898 (Morris), Bost. Myc. Herb.; Wareham, Sept. 1912 (E. C. Ellis) Bost. Myc. Herb.; Holbrook, Aug. 1899. (Alice L. Grinnell) Bost. Myc. Herb.; Manchester, Sept. 1898 (N. D. Elliott) Bost. Myc. Herb.; S. Acton, July 1918. N. Y. Bot. Gard. Herb.; Ellis, Aug. 1907 (G. E. Morris) N. Y. Bot. Gard. Herb.; Boston, July 1909 (Morris); Amherst, Oct. 1920 (Ickis & Anderson) M. A. C. Herb. It appears to be a common species in this state.

3. HELVELLA PALUSTRIS Pk. Ann. Rpt. N. Y. State Mus. Nat. Hist. 33: 31. *pl. 12, f. 16–18.* 1880

Peck's original description. Pileus irregular, at first blackish and slightly adnate, then grayish brown or mouse-colored and free, rugose beneath; stem equal, slender, sulcate-costate, colored like the pileus, the costae thin, subacute; asci cylindrical; spores broadly elliptical, .00064 in. to .0008 in. long, .0005 in. broad, containing a single large nucleus; paraphyses thickened above, brown.

Plant 1 in. to 2 in. high, pileus 6 lines to 12 lines broad, stem about 2 lines thick. Among mosses and liverworts in swamps. Manlius. Aug.

This species is related to *H. sulcata,* from which it differs in its more slender and darker colored stem, its less firm and more

free pileus and its darker colored paraphyses. In the dried specimens the upper surface of the pileus has assumed a blackish color, but the lower surface has retained very nearly its normal hue. The dark colored slender stem readily separates this species from all others with costate or lacunose-costate stems.

We have found but a single specimen of this species. The entire plant was gray, the slender stipe 5 cm. high by 3 mm. thick and beautifully fluted with prominent veins which did not anastomose. The pileus was entirely free, not firm, almost smooth beneath. Spores measured 14–18 × 7–10μ and could not be distinguished from those of other Helvellae. In order to clear up doubts about this species we studied carefully the specimens in Peck's herbarium at Albany. Six specimens were found but they were in imperfect condition. The place of collection was Manlius Center but no date was given (a frequent omission in the Peck herbarium) and it was of course impossible to say whether it was the type material. In the dried state the pilei were about 2 cm. in diam. and black, the stipe 4 cm. high × 3 mm. diam., sulcate costate, bistre or a little lighter upward, pileus attached in some but mostly free, finely wrinkled below. Whether or not the differences are sufficient to warrant the separation of this form from *H. lacunosa* as a distinct species is a question which can be answered only by study of more abundant fresh material. It is also very similar to *H. Queletiana*. In the absence of more abundant material for investigation we have considered it as a distinct species.

Massachusetts Collections: Pelham, Sept. 1917 (Anderson).

4. Helvella Queletiana Sacc. & Trav. Syll. Fung. **19:** 850. 1910

H. venosa Quél. (nec Schw.) Quél. esp. Myc. fr. 10th suppl., p. 672. 1881.

H. plebophora Sacc. (nec Pat.) Syll. **8:** 20. 1889.

Quelet's original description. Stipe court, plein, à la fin creux, lacuneux, cannelé, pruineux, gris ou bistre. Mitre bilobée, comprimée puis réfléchie et festonnée, veinée réticulée, gris clair. Hymenium glabre, brun bistré. Spore ellipsoide (O^{mm} 016–18), ocellée.

Été.—Dans les forêts de la plaine. Il me paraît distinct du *sulcata* auquel je l'avais réuni comme variété. (Pl. VIII, fig. 15.)

Late in the autumn during three successive years the writers have collected plants which they have referred to this species along the marshy wooded banks of a small sluggish stream on Mt. Toby near Sunderland. They grow from mossy rotten logs and limbs which are partly submerged in the stream, moss-covered rocks, muck, or leaf-mold but always very close to the water. Frequently specimens were found completely submerged. Because we were never fully satisfied as to the identity of these plants, very full notes were always recorded. The following description is condensed from notes on some fifty fresh specimens collected during the three years:

Pileus not saddle-shaped or compressed (except occasionally in young stages), usually convex and somewhat agariciform, irregularly undulating on the upper surface, thin and weak, easily splitting back from the wavy margin, drooping and sometimes adnate to the costae, but most often found with margins entirely free, 1–3 cm. broad, usually fuscous above, but occasionally lighter (to smoke-gray of Ridgway), lower surface concolorous with the stipe. The costae from the stipe continue outward on the lower surface of the pileus as prominent radiating and branching veins disappearing toward the margin (See fig. 7). Stipe even or frequently attenuate downward, glabrous, smoke-gray or sometimes lighter (to almost white), 2–4 cm. high by 4–7 mm. in diam., sulcate-costate, the costae narrow and high, only rarely anastomosing, entire stipe composed of these solid plate-like costae united by their inner edges. Asci 200–300 × 16–20μ, cylindrical, with 8 uniseriate spores. Spores ellipsoidal, hyaline, smooth, with large central oil drop, 14–18 × 10–12μ. Paraphyses of the same height or a little longer than the asci, septate, slender, gradually enlarging upward to 5–6μ. (*Pl. 11, figs. 6, 7.*)

The microscopic characters of the species are not distinctive but in the very prominent veins which spread over the lower surface of the free pileus it is very distinct from any other species which we have found here.

The plants seem very much like *H. palustris* of Peck both in form and in habit and were at first referred there, but Peck does

not describe that species as having a venose inferior surface and it seems hardly probable that so prominent a character as this should escape the attention of so keen an observer. Examination of Peck's specimens of *H. palustris* (in imperfect condition, to be sure) failed to show this character. *H. palustris* is also a more slender species and is said to have a darker stipe. Both Quélet and Saccardo find *H. Queletiana* very closely related to *H. sulcata* (=*H. lacunosa*) and we were at first inclined to regard it as a synonym, but we have found the two species growing only a few feet apart and as seen in the field they appear very distinct. This venose lower surface is also possessed by *H. fusca* Gill. and *H. subcostata* Cke. All three agree also in the rather free pileus and sulcate stipe. Study of a wide range of material might show that they were not all distinct.

Massachusetts Collections: Sunderland, Sept. 1917 (Anderson). Oct. 1919. (Anderson), Oct. 1920. (Ickis & Anderson) M. A. C. Herb. 2283, 2816, 2823. Apparently a rare species, no other collections having been recorded from this state and very few from elsewhere.

5. Helvella nigra Peck, Bul. Tor. Club **26**: 70. 1899

Peck's description. Pileus irregular, cupular, 1.5–2 cm. broad, externally velvety with short few-celled blackish brown or black septate hairs, hymenium even, black; stem 1.5–2 cm. long, solid, deeply sulcate and lacunosely pitted, velvety, black; asci 8-spored, 150–200μ long, 12–15μ broad; spores elliptic, 15–20μ long, 10–12μ broad; usually containing a single large shining nucleus.

Ashes of an old camp fire, Mt. Katadin, Me., Sept., F. L. Harvey.

This species is externally black and everywhere clothed with short thick black hairs except on the hymenium, but the inner substance is white. It is peculiar in having a cup-shaped though wavy and irregular ascomate or pileus. It is possible that this may become reflexed or deflexed with age, but I have seen no such specimens. The stem is rather long and conspicuously sulcate and lacunose and on this account I have referred the species to the genus *Helvella* rather than to *Acetabularia*. The hymenium is sometimes suffused with a white pruinosity.

No collections of this species have been reported from Massachusette and we can add nothing to the above description. The length and furrowing of the stipe seem to us to be hardly sufficient basis for calling this plant a *Helvella,* since neither of these characters is lacking in the Pezizales where the cup-like upright pileus would seem to place the species in the genus *Acetabula.*

6. HELVELLA EPHIPPIUM Lév. Ann. Sci. Nat. II. **16:** 240. *pl. 15, fig. 7.* 1841

Leveillé's original description. Gregaria, villosa, cinerea; pileo 2–3-lobo, deflexo, libero; stipite cylindrico, laevi, farcto.[1]

Hab. circa Parisios, ad terram in graminosis. Aestate.

Pileus firm, smooth, rather tough and membranaceous, at first pezizoid, then becoming saddle-shaped by the elevation of two opposite sides and the depression of the intervening margins, 1–3 cm. broad, margin always free from the stipe, smoke brown or bistre above, cinereous and scurfy villose below with tufts of converging, closely septate, moniliform, brown hairs increasing to 12–15μ in thickness at their apices. Stipe slender, attenuate upward, scurfy-villose like the lower surface of pileus, stuffed, terete, tough, elastic, cinereous, 1–3.3 cm. high by 2–5 mm. diam. at the base. Asci 200–300 × 14–18μ. Spores hyaline, smooth, ellipsoidal, with large central oil drop, 14–18 × 10–12μ. Paraphyses slender, septate, enlarged upward, brown-tinted. (*Pl. 12, figs. 18–20.*)

Gregarious, on the ground in grassy places and thin woods. Common in late summer and autumn.

Our specimens have been very dark gray, some of them fuscous-black. The pezizoid character is very prominent and although the older ones are frequently saddle-shaped, they become so in the manner described above and not because the lobes are reflexed from the first as in *H. atra.* We find with Leveillé however that the shape is not very constant. Many of the stipes were partly buried and in all cases a round ball of earth adheres to the base of the stipe, making it appear at first bulbose. The hairs on the lower surface are longer and the scurfy-villose character more prominent than in *H. atra,* giving the plant an almost shaggy appearance. The spores are described

[1] A long note follows this brief diagnosis in the original.

by Leveillé as round but we find them much the same as in other species of the genus except perhaps that they are a little smaller (14–16μ long in our specimens).

In this species we have a connecting link between the Helvellae and the Pezizales. One who sees only the younger cupular ascomata is inclined to place it among the latter but in more mature stages the helvelloid character appears.

Massachusetts Collections. Sunderland, Sept., 1919 (Anderson & G. W. Martin) M. A. C. Herb. 2644; Leverett, Oct., 1920 (Ickis). There are specimens under this name in the Harvard herbarium, collected by Mrs. Sanger at Manchester, Mass., in Aug. 1906, but they could hardly be *H. ephippium* as we know it, since they are much larger, have lacunose stipes, and the margins of the pilei are adnate.

In Peck's herbarium there are two packets of this species from Mass., one from G. E. Morris, of Waltham, and the other from Miss Hallowell, but no localities or dates are given.

7. Helvella elastica Fr. Sys. Myc. **2**: 21. 1823

Boleto-lichen vulgaris Jus. Mem. Ac. Sc. Paris 1728, p. 268.
Elvela fuliginosa Schaeff. Fung. *t. 320.* Index, p. 113. 1770.
H. elastica Bull. Champ. fr. p. 299. *t. 242.* 1785.
H. Mitra Bolt. Hist. fung. *t. 95.* 1789.
H. albida Pers. Syn. Meth. fung. p. 616. 1801.
H. gracilis Pk. N. Y. Sta. Mus. Nat. Hist. Rpt. **24** (for 1870): 94. 1872.
Leptopodia elastica Boud. Bul. Soc. Myc. Fr. **1**: 99. 1885.
Elvella albella Quél. Bul. ass'n. fr. Adv. Sci. **1895**: 621. *t. 6, f. 6.*
Leptopodia albella (Quél.) Boud. Ic. Myc. **4**: 123. 1910.
Helvella capucinoides Pk. N. Y. State Mus. Bul. 157: 27. 1912. (Rpt. State Bot. for 1911.)

Fries' description. Pileo libero laevi inflato, demun acute lobato, stipite elongato tenui attenuato pruinoso.

Gracilis, 3–4 unc. alta, elastica, pellucens. Stipes junior farctus, dein fistulosus, basi incrassatus, saepe irregulariter lacunosus. Pileus unciam vix attingens, 2–3-lobus, subinde orbicularis leviter plicatus.

Pileus smooth or undulate, firm, deflexed and rolled backward,

saddle-shaped or irregularly 2–3-lobed, usually tilted—so much so in some cases that it is almost vertical and the reflexed lobes encircle the stipe—margin even or wavy and free from the stipe, upper surface light-drab, smoke-gray or yellow but often found darker, through various shades of gray-brown or fuliginous, 1–3.5 cm. broad, lower surface white, pruinose to tomentose, usually areolate. Stipe slender, smooth and terete or frequently somewhat uneven and undulating, compressed at places or lacunose but never sulcate-costate, attenuate upward, pruinose to tomentose, 3–10 cm. high by 4–8 mm. diam. at the base, pure-white, sometimes darker toward the base and exhibiting there the same colors as the pileus, stuffed or finally hollow. Asci 200–300 × 12–18μ. Spores ellipsoidal, smooth, hyaline, 17–20 × 10–12μ, with large central oil drop. Paraphyses slender, septate, clavate, hyaline. (*Pl. 12, figs. 8–15.*)

On the ground and sometimes on wet rotten logs in the woods. Common in autumn.

The shape of the pileus is extremely variable. It only rarely appears to be set squarely on the top of the stipe but in our specimens has almost always been tilted at various angles as indicated by our photographs. If tilted to nearly the vertical position, the reflexed margins roll closely about the top of the stipe. Sometimes longitudinal lacunae on opposite sides extend clear through the stipe, the fissure thus formed making the stipe appear double for a part of its length (fig. 8). The stipe is always slender; we have never found one that was as much as 1 cm. in diameter; it is difficult for us to believe that they become 1 inch thick in Minn. as described by Miss Hone. *H. albella* Quél. (= *Leptopodia albella* of Boudier) is separated on the basis of a darker colored pileus. In view of the well-known variations in the shade of the pileus such a character would hardly seem sufficient for separating a species. In his supplement to Vol. II of the Systema Mycologicum, Fries states that he has seen many varieties of colors, snow-white, brown, etc.

Peck describes his new species *H. gracilis* as having the upper surface of the pileus pale-yellow, but in all other respects his description agrees with that of *H. elastica.* Cook (Mycogr. 1 (I): 91 and fig. 162) after examining the specimens of *H. gracilis* which Peck sent to him says: Size and habit that of *H. elastica,* wholly ochraceous. Sporidia 18–20 × 12μ. It is appar-

ently only different in color from the usual condition of *H. elastica,* of which it is probably only a variety." His figure shows the plant wholly ochraceous, but it was made from dried specimens and we frequently find exsiccati specimens of *H. elastica* entirely of that color. In a short key to the N. Y. species of *Helvella* (Rpt. **31**: 59. 1879.) Peck separates *H. gracilis* from *H. elastica* on the basis of its glabrous stipe. But Cooke finds his specimens of *H. gracilis* with pruinose stipes. In the N. Y. State Herb. at Albany the writers had opportunity to study numerous collections of this species by Peck but it was impossible to determine whether any of them were type specimens since Peck seems rarely to have marked his type specimens as such and also quite commonly omitted the date of collection. In the dried state nothing could be found to distinguish them from *H. elastica.* Under the lens the stipes were plainly pruinose to tomentose. The stipe and lower surface are light-ochraceous-buff, warm-buff or pinkish-buff; the upper surface varies from cinnamon-buff or clay-color to cinnamon-rufous and chestnut-brown. A drawing by Peck along with these specimens shows the upper surface of the pileus cream-buff. The form with the brown pileus is less frequent but not uncommon in this state. In Farlow's herbarium at Harvard there are a number of excellent specimens which Dr. Farlow collected at Williamstown and sent to Boudier who identified them as *Leptopodia albella.* Through some confusion of names they are labelled *H. albipes,* a species which probably does not occur in America and even in the dried condition could hardly be mistaken for *H. elastica.* Careful examination failed to show any distinction between the Williamstown specimens and other specimens which are in the Harvard and other herbaria under *H. elastica.*

Peck describes the color of the upper surface of the pileus of his new species *H. capucinoides* as smoky-ochraceous, becoming brown or ochraceous brown with age; the spores 20–28 × 12–16. A large number of the type specimens of this species at Albany were studied. The pileus was bistre to snuff-brown in color. The plants in all respects seem to agree with the exsiccati of *H. elastica* which we have seen in various other herbaria. The

spores measured 18–20 × 10–12μ and were in every way like those of *H. elastica*. Exsiccati specimens of *H. elastica* compared with Ridgway's color standard plates, are light-ochraceous-buff, warm-buff, ochraceous-tawny or ochraceous-buff on the stipe and under surface of the pileus. The upper surface varies widely, ochraceous-tawny, russet, Mars-brown, Rood's-brown, sepia to fuscous-black. It seems probable that the shade which the specimen finally assumes might be largely influenced by its condition when collected and especially by the rapidity and conditions under which it was dried.

A variety having the lower surface of the pileus and the stipe fuscous but otherwise like *H. elastica* has been reported from Vermont by Burt (1899) as *H. elastica* var. *fusca* Bull. (Champ. Fr. *pl. 242, fig. D*). Fig. D of Bulliard's plate 242, however, does not show the lower surfaces of pileus and stipe to be different in color from other plants figured on the same plate and we are at a loss to locate the authority for the variety. We have not seen specimens of it in Massachusetts.

Massachusetts Collections: Frost included this species in his list of fungi within thirty miles of Amherst College but no locality was mentioned. Underwood also writes that he collected it in this state. Manchester, Sept. 1890 (Sturgis) in Harv. Herb.; Williamstown, Sept. 1901 (Farlow) in Harv. Herb; Prides Crossing, Sept. 1901 (J. F. Conant), Bost. Myc. Herb; Amherst and Sunderland, Sept. and Oct. 1919 and 1920, (Anderson & Ickis) M. A. C. Herb. 2716, 2732, 2813. Probably as common as any species of *Helvella* in New England.

8. HELVELLA ADHAERENS Peck. N. Y. State Mus. Bul. **54**: 956. *pl. 50, figs. 11–15.* (Rpt. of Botanist for 1901.) 1902

Peck's original description. Pileus thin, irregular, deflexed, whitish or smoky white, becoming brownish with age or in drying, the lower margin attached to the stem, even and whitish beneath; stem slender, even, solid, pruniosely downy, smoky white or brownish, the upper part concealed by the deflexed pileus and smaller than the lower exposed part; asci cylindric, 8-spored; spores elliptic, often uninucleate, .0007–.0008 of an inch long, .0005 broad; paraphyses filiform, hyaline, thickened or subclavate at the top.

Ground in woods. Bolton and Hague. August and September. Related to *H. elastica,* from which it is easily distinguished by having the deflexed margin of the pileus attached to the stem. When young and fresh the whole plant is whitish or dingy white, but it us apt to become brownish with age or in drying.

In 1879 Peck (Rpt. **31**: 59) stated that he sometimes found the margin of the pileus adnate to the stem in *H. elastica.* In the present description he states that *H. adhaerens* differs from *H. elastica* in that the pileus margin of the former is adnate. The two statements in conjunction indicate that he had now decided that those plants of *H. elastica* in which the margins were attached should be placed in a separate and new species which he now describes.

Four different collections of *H. adhaerens* in the Peck herbarium at Albany were examined. Apparently two species have been confused there, one a tall species which looks very similar to *H. elastica* except for the adnate pileus and a slightly darker color; the other a smaller, very dark form with densely hairy stipe which has every character of *H. atra.* From Peck's description it seems likely that the first is the true *H. adhaerens.*

There is no record of the occurrence of this species in Massachusetts and we can add nothing to Peck's description.

9. Helvella atra Fr. Sys. Myc. **2**: 19. 1823

H. atra Oed. Fl. Dan. Fasc. **9**: 7. 1770.

H. nigricans Pers. Obs. myc. **1**: 72. 1796.

Leptopodia atra (König) Boud. Hist. et. Class. Disc., p. 37. 1907.

Fries' description. Fuligineo-nigra, pileo deflexo utrinque adpresso libero, subtus laevi, stipite farcto furfuraceo-villoso.

Solitaria, minor, *H. infulae* analoga. Stipes 1–2 unc. longus, 1–2 lin. crassus, teretiusculus, laevis l. irregulariter lacunosus, nigricans, basi subolivaceo-cinerascens. Pileus iam ab initio deflexus, nec pezizoideus uti sequ., compressus, biloboemarginatus, ½ unc. l. parum ultra latus, laevis, demum leviter repandus, subtus & exsiccatus cinerascens.

Pileus firm, smooth, reflexed, compressed-saddle-shaped, with the opposite drooping margins at first (in all our specimens) adnate with the stipe, 1–2.5 cm. broad, smoke-gray to fuliginous

above and below, lower surface smooth and velvety or scurfy-villose. Stipe smooth and terete or unevenly undulate or flattened or with some lacunae, especially toward the base but never sulcate-costate, attenuate upward, fuscous to fuscous-black but gray at the extreme base, villose like the lower surface of the pileus, stuffed, 2–5 cm. high and 2–7 mm. thick at the base. Asci 200–300 × 15–18μ, cylindrical. Spores smooth, hyaline, ellipsoidal, with one large and a number of much smaller oil drops, 15–20 × 9–12μ. Paraphyses slender, septate, enlarging upward to 8–9μ, hyaline to yellow-brown-tinted. (*Pl. 12, figs. 16–17.*)

Gregarious on the ground and on wet rotten logs in the woods in autumn.

We have found this species but once in this state and since this is the only recorded collection from New England, we judge that the species is rare with us. Five specimens were found growing on a very wet rotten maple log, in the edge of a swamp in October. In all of our specimens the margins of the pileus are adnate with the stipe but Fries and Rehm describe the pileus as free. Bresadola, Boudier, Massee and others find that it is sometimes adnate. In the face of such conflicting statements it seems best to describe it as sometimes adnate. In other respects our specimens agree very closely with the descriptions of Fries and Rehm. There is also some variation in the color of the upper surface of the pileus; Fries describes it as fuliginous, Rehm as smoke brown, Massee as sooty-black or black with a purple shade becoming dingy-gray, Gillet presents a figure in which it is grayish-white, etc. The pilei of our specimens were smoke-gray to deep-mouse-gray while the stipes were fuscous to fuscous-black, much darker than the pilei but gray at the extreme base. Rehm finds a close relationship between this species and *H. pezizoides* and *H. ephippium* but if our specimens are typical, it is very easily distinguished from the two latter species by the regularly saddle-shaped pileus, deflexed and compressed, adnate and not at all pezizoid. The main points of resemblance are the dark color and the villose stipe and under surface of the pileus. The adnate margins distinguish it from all the forms of *H. elastica.* It also differs in the color of the stipe from all of them (except *H. elastica* var. *fusca*) and in the villose character of the lower sur-

face and stipe. The very dark color of the stipe distinguishes it from *H. adhaerens*.

Massachusetts Collections: Sunderland, Oct. 1920 (Ickis & Anderson) M. A. C. Herb. 2825. Apparently rare.

10. Helvella Monachella Fr. Sys. Myc. **2**: 18. 1823

Morchella monacella Port. Hist. X, c. 70. 1592.
Fungoidea fungiformia 6. Mich. N. Pl. Gen. p. 204. 1729.
Boletus albus Batt. Fun. Agr. ari. Hist. p. 24, *t. 2, f. H.* 1759.
Phallus monacella Scop. Fl. Carn. **2**: 476. 1772.
Elvela spadicea Schaeff. Fung. **4**: index p. 112. *t. 283.* 1770.
Helvela grandis Cum. Act. Ac. Taurin, *t. 2.* 1805.

Fries' description. Pileo deflexo lobato adnato laevi subspadiceo, stipite cavo laevi glabro albo.

Antecedenti proxima, sed notis allatis & vegetatione vernali bene distincta. Stipes 1–2 unc. longus, sursum attenuatus, ½ unc. vix crassus, primo teres; dein subcompressus versus basin lacuna notatus. Pileus demun crispus et undulatus, colore varius, badius, spadiceus, violaceous, nigrescens, etc.

Pileus irregularly lobed, undulate, deflexed and adnate to the stipe, 3–6 cm. broad, pale-brown, chestnut-brown or darker to violaceous or blackish above, much lighter below. Stipe terete or somewhat compressed, smooth, hollow, somewhat swollen below, attenuate upward, minutely pubescent but becoming glabrous, 2–5 cm. high, 1 cm. thick, white. Asci cylindrical. Spores ellipsoidal, hyaline, smooth, with large central oil drop, 16–18 × 10μ. Paraphyses slender, septate, enlarging upward, brown at the tips.

Solitary in woods on the ground in spring.

The writers have not seen a fresh plant of this species; the above description being taken from those of Fries, Rehm, Massee, Gillet, and others. It appears to be a rare plant in America, having been reported only from New England and California. It is said to be common in Italy but even the European literature is scanty and based on very few collections. Rehm has well said that the species is in need of further investigation; it is doubly true of American collections. Fries finds that it is very closely related to *H. Infula* (*Gyromitra*), and on comparing his descriptions of the two species, one wonders what the important morphological differences are. It differs from all our other Helvel-

lae and at the same time agrees with our Gyromitrae in its vernal habit. Its size, color and stout stipe also indicate a relationship to *Gyromitra*. The spores as described by Rehm are like those of *Helvella* rather than *Gyromitra*. In the few herbarium specimens which we have found and examined microscopically the spores were biguttulate and we are inclined to believe that the specimens were incorrectly referred to this species. We have included a consideration of this species in this paper, even though based on very scanty data in the hope that mycologists might be induced to look more carefully for it and settle the question as to its identity.

Massachusetts Collections: Sprague (1858) included this species in his second list of New England fungi and indicates by the context that it was collected in the vicinity of Boston. Morris (1918) has doubtfully attached this name to a drawing of a species which he collected at Ellis in Sept. 1913. If it was *H. Monachella,* it differed from the European plant in its autumnal occurrence.

11. MACROPODIA MACROPUS (Pers.) Fckl. Sym. Myc. p. 331. 1871

Helvella macropus Karst. Myc. fenn. **1**: 37. 1871. (For full synonymy, see Rehm, Rabh. Krypt. Fl. Bd. I, Abt. **3**: 985. 1896.)

Pileus at first globose and closed, then opening to expose the grayish-brown hymenial surface, which is at first cup-shaped, then saucer-shaped, 1–3 cm. broad, smooth above, coriaceous, fragile. Stipe cylindrical, 1–4 cm. high, 1–3 mm. in diameter, hollow, attenuate upward, frequently somewhat lacunose. The stipe and lower surface of the pileus are gray, scurfy-villose, with tufts of closely septate moniliform clavate hairs, 10–12μ thick at their apices. Asci cylindrical, 300–350μ × 14–16μ. Spores ellipsoid-fusiform, hyaline, smooth or sometimes rough, mostly with a large central oil drop, 18–25 × 10–12μ. Paraphyses slender, septate, enlarging upward to 8μ, yellowish.

This is not a true *Helvella* but is included in this paper because frequently called a *Helvella* (following Karsten), and because it is commonly found in Massachusetts. The early closed

condition of the ascoma and its more permanent cup-shape place it among the Pezizales rather than among the Helvellales. Phillips (1893) finds however that the cups sometimes become expanded or even reflexed. In this condition it would be more easily taken for a *Helvella.* The above description is taken largely from Rehm. Massee describes the plants as somewhat larger, 2–5 cm. broad and 3–7 cm. high; also he finds the spores 28–33 × 11–13μ. Boudier (Icon. Myc. **4**: 126) finds that it sometimes grows 10 cm. high, never reflexed, the spores having usually 3 oil drops, 24–29 × 11–12μ, fusiform. Among the Massachusetts Helvellae it is most closely related to *H. ephippium,* from which species it is probably most easily separated by its larger ellipsoid-fusiform spores.

Peck (Bul. Tor. Club **29**: 74. 1902) described *Helvella macropus* v. *brevis* from some small specimens which were sent to him from this state by Morris. Stipe 8–16 mm. long and pileus 8–16 mm. broad, hymenial surface black or nearly so. These differences seem hardly sufficient basis for the separation of a variety. The writers studied the type specimens at Albany as well as another collection sent to Peck by Simon Davis from Mass. The specimens were very similar to our exsiccati of *H. ephippium,* but the spores are distinctly fusiform, minutely tuberculate and measure 18–25 × 10–12μ, corresponding in every respect with those of *Macropodia macropus.*

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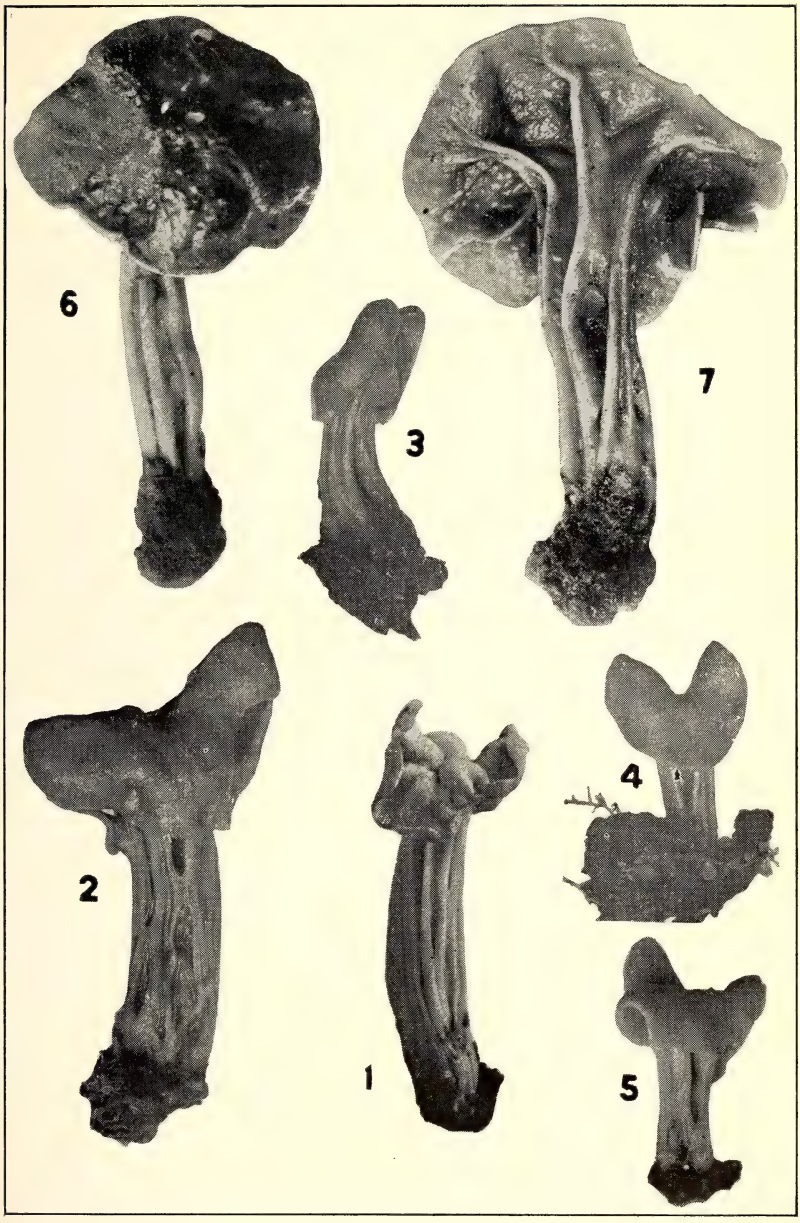

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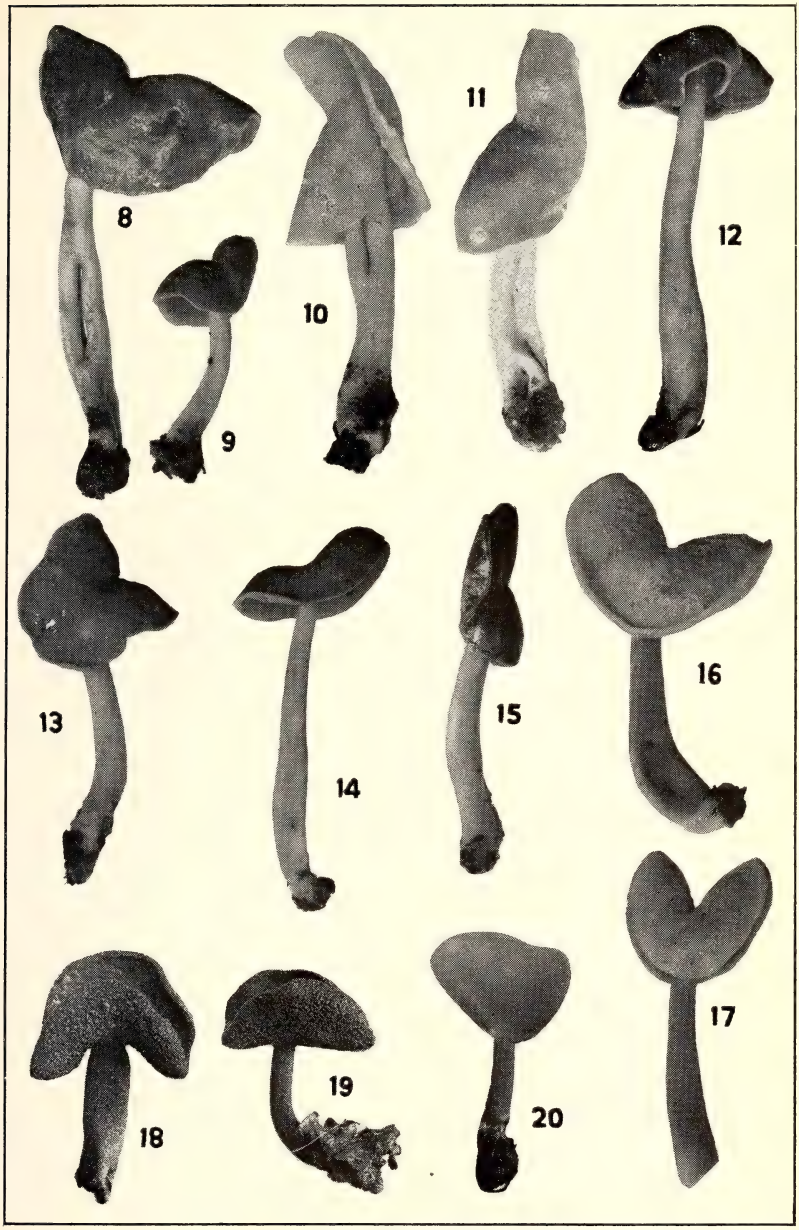

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MEMORANDA AND INDEX OF CULTURES OF UREDINEAE, 1899–1917[1]

J. C. Arthur

The cultures of the rusts, which were conducted under the auspices of the Purdue University Agricultural Experiment Station, and extended over a period of nineteen years, had a small beginning. For the first three years only such time was given to the work as the writer could spare from his duties as head of the Botanical Department of the Station and as Professor of Vegetable Physiology and Pathology in Purdue University. In most of the following years an assistant was especially employed during two or so months each spring, who had entire charge of the testing of spore viability, sowing of the spores, and care of the inoculated plants, the chief part of the culture work being done during May and June. The position was held by fourteen individuals, selected with the needs of the work especially in view, and ranging from a junior high school student to university instructors, who without exception showed superior ability in conducting the work. Financial support was provided by a grant from the Botanical Society of America in 1903, 1906 and 1907, and by coöperation with the Bureau of Plant Industry of the U. S. Department of Agriculture in 1904 and 1905. In the other years it was supplied by the Purdue University Agricultural Experiment Station, and from 1908 onward the work was made a part of the rust project under the Adams fund.

During the progress of the work the writer, usually accompanied by an associate, made many shorter or longer excursions for securing data and material. These field observations were directed toward detecting the juxtaposition of spore-forms that might be supposed to have genetic connection, as well as toward securing suitable culture material. The fruitfulness of this method is apparent from the fact that during the extended study

[1] Contribution from the Botanical Department of the Purdue University Agricultural Experiment Station.

of heteroecious species only three times was a discovery of alternate hosts effected that was not the outcome of a previous field observation. In two of these cases, that of *Uromyces acuminatus* (more properly *U. Steironematis,* see page 76,* Jour. Myc. **12**: 25), and *Puccinia Ceanothi* (see page 196,* Mycologia **4**: 27) sowings were made on all available hosts in the greenhouse, recorded as bearing aecia, and in the case of *P. fraxinata* (*P. peridermiospora,* see page 8,* Bot. Gazette **29**: 275), a morphological similarity was detected between aesciospores and urediniospores, leading to successful cultures.

Beginning with the immediate vicinity of Lafayette, Indiana, the range of observations was extended to various parts of the state, and in the ninth year of the work, 1907, to other states. This year a trip was made to the foothills of Colorado, which was repeated in 1908, 1911 and 1916, observations being made from Boulder to Trinidad, and once westward to Ouray and Durango. Between 1908 and 1916 trips were made northward to Wisconsin and Michigan, eastward to Maine and Pennsylvania, to South Carolina, Alabama and Mississippi in the south, and to Texas, New Mexico and Arizona in the southwest. So far as possible places were selected where there were local collectors, or where records showed that species requiring investigation had at some time been secured. The chief collecting grounds of Ellis in New Jersey, Ravenel in North and South Carolina, Atkinson and Underwood in Alabama, and Kellerman in Kansas were visited, and the collecting grounds of Schweinitz at Salem, North Carolina, and Bethlehem, Pennsylvania, would have been visited, if opportunity had favored. In this way many obscure names in the literature were connected with living material on which fresh and more extended studies, often including cultures, could be carried out. By this method the attention given to the genus Gymnosporangium was made to expand our limited knowledge of a few species into an understanding of the life history of some two dozen species and of their alternate hosts. The effectiveness of the work with Gymnosporangium was greatly enhanced by the special interest in it taken by my asso-

* For explanation of these page numbers see p. 246 at beginning of the index.

ciate, Dr. F. D. Kern, who for ten years took part in the culture work. The grass and sedge rusts were, however, the ones that received the most extended and prolonged attention.

To carry on the work more than 2140 collections with resting spores were available, together with over 250 collections with spores not requiring a resting period. Tests of all of these, and of some many times repeated, showed that not all were viable, at least at the time tested, and therefore not serviceable. This material was provided in part by those directly connected with the work, and to a considerable extent by more than 85 botanical correspondents, many of whom contributed most generously in material and field observations year after year. Altogether about 3750 sowings, that is, attempts at cultures were made, of which about one in seven resulted in successful infection of the host. These tests were almost wholly made in a greenhouse, although a few were conducted in the open field when small plants suitable for placing in pots were not available.

It is difficult to say just how many species have been grown through some part of their life cycle during the nineteen-year period, owing to the constant shifting of accepted names as knowledge regarding them accumulated. Probably the list includes about one hundred species, as they are now rated, or nearly twice as many as they would at first have been listed, and of this number about eight were heteroecious to one autoecious. Of the heteroecious species some twenty were verifications of combinations previously established, mostly by European investigators, while about sixty-five provided alternate hosts for species whose life cycle was before unknown, most of these being grass and sedge forms not known outside of North America.

When viewing the present location of the New York Botanical Garden many years ago, it then being a rolling meadow without buildings of any kind, my companion, Professor L. M. Underwood, remarked that some day I might be called upon to supply the rust portion for the projected North American Flora, and added that if I did so he had no doubt that I would greatly reduce the number of species. The culture studies have enabled me to do this, but not quite in the way Professor Underwood

and others at that time had in mind. In many cases the first results have been to increase the number of species. Thus *Puccinia alternans* and *P. obliterata* were described as new species as result of cultures, but as the studies proceeded were reduced to synonyms of the long recognized *P. Agropyri,* together with *Aecidium Aquilegiae, A. Clematidis, Puccinia tomipara, P. Paniculariae,* and some others. But on the whole, as the cultures have largely dealt with heteroecious species, there has been a reduction in names as the alternate forms were brought together, and sometimes by the recognition as races of forms that were once thought distinct species.

The nomenclature of the reports has been made as conservative as possible, in order to give them reasonable uniformity. The new generic names proposed by the writer in 1906 at the Vienna Congress scarcely find an echo in them, while on the other hand the terminology for spore-forms, brought out in 1905, was put into use in the second report following, and proved highly serviceable.

In the various reports of the cultures, and as a result of them, the following thirteen specific names were transferred to other genera: *Aecidium magnatum* Arth. and *A. Silphii* Sydow to Uromyces, *Aecidium Ceanothi* Peck, *A. Impatientis* Schw., *A. Jamesianum* Peck, *A. macrosporum* Peck, *A. monoicum* Peck, *A. Pammelii* Trel., *A. Phrymae* Halst., *A. pustulata* Curt., *A. Sambuci* Schw. to Puccinia, and *Puccinia tumidipes* Peck and *P. Vernoniae* Berk. & Curt. to Bullaria.

Also as the result of the cultures the following sixteen species were described as new: *Gymnosporangium corniculans* Kern, *G. exterum* Arth. & Kern, *G. trachysorum* Kern, and on the authority of the writer *Puccinia albiperidia, P. alternans, P. Caricis-Asteris, P. Caricis-Erigerontis, P. Caricis-Solidaginis, P. Eatoniae, P. Koeleriae, P. obliterata, P. patruelis, P. universalis, Uromyces effusus, U. Solidagini-Caricis,* and *U. Steironematis,* but as the result of further studies most of these were subsequently buried in synonymy.

CORRECTIONS

In making corrections the consecutive page numbers used are those explained below at the beginning of the index, while the original pages are given in parentheses. A few of the corrections are typographical errors, or slips of the pen, but many are necessitated by information variously acquired after the reports were written and printed. Evident and inconsequential errors are not included. To save space the following abbreviations are used in the parentheses: B.G. for Botanical Gazette, J.M. for Journal of Mycology, and My. for Mycologia, and are followed by the original volume and page number.

Pages 5, 9 (B.G. **29**: 272, 276), under 7 and 3 respectively, for "Americana Lagh." and "Americana," read Andropogonis Schw. and Andropogonis, respectively, and for "Andropogi Schw." and "Andropogi," read Ellisiana Thüm. and Ellisiana, respectively.

Pages 7, 9, 22, 28 (B.G. **29**: 274, 276; **35**: 16, 22), for "K. & S.," read E. & K.

Pages 8, 31, 51, 60, 67, 75, 76, 77, 78, 83, 103, 106, 114, 127, 146, 156, 160, 164, 174 (B.G. **29**: 275; J.M. **10**: 9; **11**: 57, 66; **12**: 16, 24, 25, 26, 27; **13**: 192; **14**: 14, 17, 25; My. **1**: 236, 255; **2**: 221, 225, 229, 239), for the species of Spartina, given as "cynosuroides" or "cynosuroides Willd.," read Michauxiana or Michauxiana Hitchc. The two species of grass were for a time confused and one name used for both.

Pages 11, 65, 77, 86, 94 (J.M. **8**: 52; **12**: 14, 26; **13**: 196, 204), for a species of Carex, for "tetanica" and "tetanica Schk.," read blanda and blanda Dewey, respectively.

Pages 17, 45, 49, 50, 60 (B.G. **35**: 11; J.M. **11**: 51, 55, 56, 66), for the species of Lepidium, given as "apetalum" and "apetalum Willd.," read densiflorum and densiflorum Schrad., respectively.

Page 26 (B.G. **35**: 20), the Aecidium mentioned under 5. P. AMPHIGENA was subsequently found not to be *A. Smilacis* Schw.

Pages 41, 42 (J.M. **10**: 19, 20). The supposed infection in 1903 of *Bromus ciliatus* by the application of aeciospores from *Dirca palustris* was the most serious error that occurred in the nineteen years of culture work. The grass used for the culture was undoubtedly infected before the sowing was made, as explained on pages 56 and 57 of the report following. The combination of aecia and telia under the name "*Puccinia hydnoidea*," was unwarranted. The *Aecidium hydnoideum* was under close observation during the whole culture period, and there were a score of attempts to find the alternate host, but even to the present writing no progress has been made.

Pages 49, 50 (J.M. **11**: 55, 56), under no. 4, for the species of Sophia from Nebraska, given as "incisa (Engelm.) Greene," read intermedia Rydb.

Pages 49, 60, 68, 77 (J.M. **11**: 55, 66; **12**: 17, 26), for the species of Sophia from Indiana used in the cultures, given as "incisa" and "incisa (Engelm.) Greene," read brachycarpa and brachycarpa Rydb.

Pages 51, 60, 67, 77, 103, 114, 127, 146, 160, 174, (J.M. **11**: 57, 66; **12**: 16, 26; **14**: 14, 25; My. **1**: 236, 255; **2**: 225, 239), after Puccinia fraxinata, for "Schw.," read Link.

Page 62, first line of reprint, for "1," read 12.

Page 64 (J.M. **12**: 13), under no. 6, for "Schw.," read Desmaz.

Pages 66, 77 (J.M. **12**: 15, 26), under no. 7, for specific name "aquatilis" and "aquatilis Wahl.," read nebraskensis and nebraskensis Dewey. On page 66 the comparison of the large, thick-walled urediniospores (common on this host, the form being known as *Puccinia Garrettii* Arth.) to the amphispores of *P. Caricis-stictae* was an error. It may be pointed out here that the same mistake regarding name of the host also occurs in Sydow, Uredineen *2115*, Barth. Fungi Columb. *2351* and *3838*. *Carex nebraskensis* is a very common sedge about Denver and Boulder, Colo., while *C. aquatilis* is rare or possibly absent.

Pages 85, 92, 94 (J.M. **13**: 195, 202, 204), under Lactuca, for "virosa," read scariola.

Pages 93, 95, 107, 114, 130, 146, 195, 201 (J.M. **13**: 203, 205; **14**: 18, 25; My. **1**: 239, 255; **4**: 26, 32), under Gymnosporangium, for "Nelsoni Arth.," read juvenescens Kern, and also delete the last sentence under no. 19 on page 107 (J.M. **14**: 18). *Gymnosporangium Nelsoni* and *G. juvenescens* were for a time confused. Both produce aecia on Amelanchier and Sorbus, but the former gives rise to woody galls, often very small, while the latter is foliicolous.

Page 96, first line of the reprint for "1907," read 1908.

Pages 100, 180 (J.M. **14**: 11; My. **4**: 11), under Puccinia, for "montanensis Ellis," read Agropyri Ellis & Ev., as pointed out on page 263 (My. **8**: 139).

Pages 109, 115 (J.M. **14**: 20, 26), under no. 2, for "Cryptandri Ellis & Barth.," read substerilis Ellis & Ev., and for "Sporobolus cryptandrus (Torr.) A. Gray," read Stipa viridula Trin.

Pages 112, 115 (J.M. **14**: 23, 26), under no. 6, for "mutabilis Ellis & Gall.," read Blasdalei Diet. & Holw., for "reticulatum Fraser," read Brandegei S. Wats., and for "recurvatum Rydb.," read cernuum Roth.

Page 123 (My. **1**: 232), under no. 11, for "Aster arenarioides D. C. Eaton," read Erigeron arenarioides A. Gray.

Pages 129, 130, 146 (My. **1**: 238, 239, 255), the small form of Gymnosporangium on Juniperus virginiana, which gave rise to pycnia and aecia on *Crataegus punctata*, should have been referred to *G. floriforme* Thaxter.

Page 133 (My. **1**: 242), delete the entire paragraph beginning "The aecia of this species," etc., except the first sentence.

Page 147 (My. **1**: 256), under no. 8, for "glomerata," read mexicana (L.).

Page 173 (My. **2**: 238), under no. 1, change the reading thus: Teliospores on *Carex lanuginosa* Michx., sown on *Onagra biennis* (L.) Scop., and on *C. trichocarpa* Muhl. sown on *Gaura biennis* L.

Pages 178, 180 (My. **4**: 9, 11), 19th and 6th line from bottom respectively, for "Douglasii," read spartioides.

Pages 180, 189, 197, 200, 231 (My. **4**: 11, 20, 28, 31; **7**: 72), as a species of Senecio, for "lugens" or "lugens A. Gray," read spartioides or spartioides T. & G., respectively.

Pages 197, 202 (My. 4: 28, 33), under no. 2, the material in hand from Isle au Haut, Me., was *Puc. quadriporula* (*P. Grossulariae*), but the results of infection were obtained from stray spores of *Uromyces perigynius,* as explained at page 235 (My. 7: 76) in the report of cultures for 1912.

Pages 256, 265 (My. 8: 132, 141), under no. 4, for "Agropyri E. & Ev. (P. alternans Arth.)," read Cockerelliana Bethel. This distinctive species was not recognized, and had not been named until long after the cultures were made.

Pages 257, 265, (My. 8: 133, 141), under no. 5, for "Anchusa officinalis," read Lycopsis arvensis.

Pages 261, 263, 265 (My. 8: 137, 139, 141), under no. 3, for "montanensis Ellis" and "montanensis," read apocrypta Ellis & Tracy and apocrypta, respectively. On page 262 three species are confused. *Puccinia apocrypta* is not a synonym of *P. Agropyri.* The characters given for *P. apocrypta* are those of the true *P. montanensis,* for which the type is the collection cited.

Pages 274, 275 (My. 9: 302, 303), under no. 2, for "B. & C." read Schw.

SUMMARY OF CULTURES

In order to give a clearer perspective of the work, and to make the data more readily available, the following tabulation is given of the heteroecious species that were successfully grown on alternate hosts. Autoecious species, and heteroecious species grown from urediniospores or amphispores only, have not been included. The years are those in which successful cultures were carried out. Only such synonymy is given as will account for the names used at different times in the reports. The page numbers are those explained below at the beginning of the index. Pages in broad faced type indicate the host from which spores were taken for culture, while pages in common type indicate the host on which the culture was successfully established.

Year	Rust	Telial host	Aecial host
1904 1905	*Puc. Sorghi* Schw.	*Zea Mays* 59, **68**	*Oxalis corniculata* (*O. cymosa*) **59, 68**
1909	*Puc. Ceanothi* (E. & K.) Arth.	*Andropogon Hallii* **168**	*Ceanothus americana* 168
1912	*Puc. Ellisiana* Thüm.	*Andropogon* sp. **230**	*Viola cucullata* 230 *V. Nuttallii* 230
1899 1903 1906 1910	*Puc. Andropogonis* Schw. (*P. americana* Lagerh.)	*Andropogon scoparius* **5**, 6, **33**, **87**, **186** *A. virginicus* **186**	*Pentstemon hirsutus* (*P. pubescens*) 5, **6**, **33**, 87, 186 *P. alpinus* 186
1903 1905 1910	*Puc. pustulata* (Curt.) Arth.	*Andropogon furcatus* **39**, **67**, **186** *A. scoparius* **39**	*Comandra umbellata* 39, 67, 186
1904 1905 1907	*Puc. Pammelii* (Trel.) Arth. (*P. Panici* Diet.)	*Panicum virgatum* **50, 67, 105**	*Euphorbia corollata* 50, 67 *E. marginata* 105
1901 1904 1905 1906 1907 1909 1910 1916	*Puc. poculiformis* (Jacq.) Wettst. (*P. graminis* Pers.)	*Agropyron pseudorepens* **162** *A. repens* **51** *A. Smithii* **270** *A. tenerum* **51, 105, 187** *Agrostis alba* **68, 88, 187** *Avena sativa* 105 *Cinna arundinacea* **12** *Elymus canadensis* **51, 88, 270** *Hordeum vulgare* 88 *Sitanion longifolium* **162, 187** *Sporobolus cryptandrus* **270** *Triticum aestivum* (*T. vulgare*) 88, 162	*Berberis vulgaris* 12, 51, 68, **88, 105, 162**, 187, 270
1917	*Puc. Majanthae* (Schum.) Arth.	*Phalaris arundinacea* **278**	*Iris versicolor* 278
1904 1910 1912	*Puc. Stipae* Arth.	*Koeleria cristata* **189** *Stipa comata* **231** *S. spartea* **58, 188**	*Aster ericoides* 58, 188 *A. multiflorus* 58, 188 *A. Novae-Angliae* 58, 188 *Grindelia squarrosa* 188 *Gutierrezia Sarothrae* 231 *Senecio spartioides* 189, 231 *Solidago canadensis* 188

Year	Rust	Telial host	Aecial host
1917	*Puc. Sporoboli* Arth.	*Sporobolus heterolepis* **280**	*Allium cernuum* 280 *A. Nuttallii* 280 *Lilium umbellatum* 280
1899 1902 1904 1905	*Puc. verbenicola* (E. & K.) Arth. (*P. Vilfae* Arth. & Holw.)	*Sporobolus longifolius* 7, **22, 50, 67**	*Verbena stricta* **7**, 22 *V. urticifolia* 22, 50, 67
1902 1904 1905 1906 1907 1908 1909 1910 1911 1915 1916 1917	*Puc. subnitens* Diet.	*Distichlis spicata* **25, 49, 68, 87, 104, 126, 160, 188, 208, 259, 273, 278**	*Abronia fragrans* 273 *Atriplex hastata* 126, 160, 208 *Bursa Bursa-pastoris* 68, 104 *Chenopodium album* 25, 87, 104, 126, 160, 188, 208, 259, 278 *Cleome spinosa* 49, 208 *Erysimum asperum* 49, 68 *Lepidium densiflorum* (*L. apetalum*) 49 *L. virginicum* 49, 68 *Polygonum aviculare* 273 *Sarcobatus vermiculatus* 87, 126 *Sophia brachycarpa* 49, 68
1908 1909 1910 1914 1916	*Puc. Muhlenbergiae* Arth. & Holw. (*P. tosta* Arth.)	*Muhlenbergia gracillima* **271** *M. mexicana* **142** *M. racemosa* (*M. glomerata*) **161, 187** *Schedonnardus paniculatus* **272** *Sporobolus asperifolius* **240, 241**	*Callirhoe involucrata* 142, 161, 187 *Malvastrum coccineum* 271, 272 *Sphaeralcea digitata* 241 *S. incana* 240 *S. lobata* 241
1902 1903 1905 1907 1909 1910	*Puc. amphigena* Diet.	*Calamovilfa longifolia* **26, 33, 67, 104, 160, 187**	*Smilax herbacea* 26 *S. hispida* 26, 33, 67, 104, 160, 187
1911 1912	*Puc. monoica* (Peck) Arth.	*Koeleria cristata* 234 *Trisetum majus* 213 *T. subspicatum* 213, **234**	*Arabis* sp. **213, 234**
1904 1910 1916	*Puc. Rhamni* (Pers.) Wettst. (*P. coronata* Corda)	*Agrostis* sp. **271** *Avena sativa* 52 *Calamagrostis canadensis* **187**	*Rhamnus alnifolia* 187 *R. caroliniana* **52** *R. cathartica* **52** *R. lanceolata* **52** *R. Purshiana* 271

Year	Rust	Telial host	Aecial host
1899 1904 1905 1907 1908 1909	*Puc. fraxinata* (Link) Arth. (*P. peridermiospora* Arth.)	*Spartina Michauxiana* (not *S. cynosuroides*) **8, 51, 67, 103, 160** *S. polystachya* **127** *S. stricta* **127**	*Fraxinus lanceolata* (*F. viridis*) 8, 51, 67, 103, 127, 160
1915 1916	*Puc. Distichlidis* E. & E. (*P. Kelseyi* Syd.)	*Spartina Michauxiana* **261, 271**	*Scironema ciliatum* 261, 271
1905 1908 1910 1915	*Puc. Seymouriana* Arth.	*Spartina cynosuroides* **259** *S. Michauxiana* (not *S. cynosuroides*) **75, 127, 188, 258**	*Apocynum cannabinum* 258 *Asclepias syriaca* 259 *Cephalanthus occidentalis* 75, 127, 188
1902 1910	*Puc. Jamesiana* (Peck) Arth. (*P. Bartholomaei* Diet.)	*Bouteloua curtipendula* (*Atheropogon curtipendulus*) **24, 188**	*Asclepias incarnata* 24 *A. syriaca* 24, 188
1899 1907 1909 1911	*Puc. Phragmitis* (Schum.) Körn.	*Phragmites communis* (*P. Phragmites*) **2, 104, 160, 208**	*Rumex crispus* 2, 104, 160, 208 *R. obtusifolius* 2
1902 1907	*Puc. simillima* Arth.	*Phragmites communis* (*P. Phragmites*) **26, 104**	*Anemone canadensis* 26, 104
1899 1902 1904 1915	*Puc. Windsoriae* Schw.	*Tridens flavus* (*Triodia cuprea, Tricuspis seslerioides*) **6, 22, 50, 260**	*Ptelea trifoliata* **6**, 22, 50, 260
1903	*Puc. Eatoniae* Arth.	*Eatonia pennsylvanica* 40	*Ranunculus abortivus* **40**
1908	*Puc. Koeleriae* Arth.	*Koeleria cristata* 138	*Mahonia Aquifolium* 138
1916	*Puc. Liatridis* (E. & A.) Bethel	*Koeleria cristata* **273**	*Laciniaria punctata* 273
1910	*Puc. Crandallii* Pam. & Hume	*Festuca confinis* **196**	*Symphoricarpos racemosus* 196
1915	*Puc. Cockerelliana* Bethel	*Festuca Thurberi* **256**	*Thalictrum dioicum* 256
1908 1915	*Puc. Asperifolii* (Pers.) Wettst.	*Secale cereale* **128, 257**	*Lycopsis arvensis* 128, 257
1915	*Puc. apocrypta* Ellis & Tracy	*Agropyron tenerum* 262 *Elymus virginicus* 262	*Hydrophyllum capitatum* **262**

Year	Rust	Telial host	Aecial host
1904 1906 1907 1908 1909 1911 1912 1914	*Puc. Clematidis* (DC.) Lagerh. (*P. Agropyri* E. & E., *P. tomipara* Trel., *P. cinerea* Arth. *P. alternans* Arth., *P. obliterata* Arth.)	*Agropyron biflorum* **140** *A. pseudorepens* **105** *A. Smithii* **232** *A.* sp. **161** *Bromus purgans* **87, 127** *B. ciliatus* **56** *B. Porteri* **139** *Elymus canadensis* **232** *E. virginicus* **242** *Puccinellia airoides* **137, 208**	*Anemone cylindrica* 232 *Aquilegia canadensis* 140, 161 *Clematis Drummondii* 242 *C. ligusticifolia* 232 *C. virginiana* 56, 87, 105, 127 *Oxygraphis Cymbalaria* (*Ranunculus Cymbalaria*) 137, 208 *Thalictrum alpinum* 161 *T. dioicum* 139 *Viorna Scottii* 105
1902 1903 1904 1909	*Puc. Impatientis* (Schw.) Arth.	*Elymus canadensis* 162 *E. striatus* **161**, 162 *E. virginicus* **25, 33, 51**, 162	*Impatiens aurea* 25, 33, 51, 161, **162**
1907	*Puc. obtecta* Peck	*Scirpus americanus* **109**	*Bidens connata* 109 *B. frondosa* 109
1899 1901 1904 1906 1907 1908 1910 1911 1912	*Puc. angustata* Peck	*Scirpus atrovirens* 6, **12, 52, 86, 103, 186, 230** *S. cyperinus* **125, 208**	*Lycopus americanus* **6**, 12, 52, 86, 103, 186, 208, 230 *L. uniflorus* (*L. communis*) 125
1915	*Puc. Eriophori* Thüm.	*Eriophorum viridicarinatum* 255	*Senecio aureus* **255**
1905	*Puc. canaliculata* (Schw.) Lagerh.	*Cyperus esculentus* 74	*Xanthium "canadense"* **74**
1905 1906 1908	*Puc. Eleocharidis* Arth.	*Eleocharis palustris* **74, 87, 124**	*Eupatorium perfoliatum* 74, 87, 124
1908	*Puc. macrospora* (Peck) Arth.	*Carex comosa* **134**	*Smilax hispida* 134
1901 1903 1904 1905 1906 1907 1910 1912 1913 1915	*Puc. Grossulariae* (Pers.) Lagerh. (*P. albiperidia* Arth.),	*Carex arctata* **226, 254** *C. blanda* **65, 86** *C. crinita* **53, 86, 102, 226** *C. flexuosa* (*C. tenuis*) **182, 226, 254** *C. gracillima* **33, 53** *C. pallescens* **182** *C. pubescens* **12, 225** *C. squarrosa* **86** *C. sp.* **237**	*Ribes aureum* 53 *R. Cynosbati* 12, 33, 53, 86, 102, 182, 225, 226, 237, 254 *R. gracile* 65, 86 *R. rotundifolium* 53, 86 *R. uva-crispa* 33, 53

Year	Rust	Telial host	Aecial host
1901 1902 1905 1907 1909 1910	*Puc. Caricis* (Schum.) Schroet.	*Carex aristata* **158, 186** *C. nebraskensis* **66** *C. riparia* **22, 103** *C. stipata* **66, 103** *C. stricta* **11, 22, 186**	*Urtica gracilis* 11, 22, 66, 103, 158, 186
1914	*Puc. minutissima* Arth.	*Carex filiformis* **245**	*Decodon verticillatus* 245
1907 1909 1910 1916	*Puc. universalis* Arth.	*Carex filifolia* **270** *C. stenophylla* **110, 159, 185**	*Artemisia dracunculoides* 110, 159, 185 *A. gnaphalodes* 270
1907	*Puc. Phrymae* (Halst.) Arth.	*Carex longirostris* **111**	*Phryma leptostachya* 111
1901 1902 1904 1905 1907 1908 1909 1910 1912 1913 1914 1915	*Puc. Asterum* (Schw.) Kern (*P. extensicola* Plow., *P. Caricis-Asteris* Arth., *P. Caricis-Erigerontis* Arth., *P. Caricis-Solidaginis* Arth., *P. Dulichii* Syd.)	*Carex festiva* **159, 185** *C. festucacea* **13, 22, 52** *C. foenea* **13, 14, 21** *C. Jamesii* **27** *C. retrorsa* **228** *C. rosea* **102** *C. scoparia* **184, 228, 229** *C. sparganioides* **66, 124** *C. stipata* **27** *C.* sp. **102** *C. vulpinoidea* **238, 240** *Dulichium arundinaceum* **240, 254**	*Aster adscendens* 159, 185 *A. cordifolius* 14, 102 *A. paniculatus* 13, 14, 21, 102, 228 *Erigeron annuus* 13, 22, 52 *E. philadelphicus* 22 *Euthamia graminifolia* 184, 229 *Leptilon canadense* 22 *Solidago caesia* 27 *S. canadensis* 27, 66, 124, 238, 240, 254 *S. glaberrima* 238 *S. mollis* 238 *S. rigida* 27 *S. rugosa* 238 *S. serotina* 27 *S. ulmifolia* 27
1902 1904 1905 1906 1908 1909 1910 1911	*Puc. Peckii* (DeT.) Kellerm.	*Carex lanuginosa* **52, 66, 85, 158, 184, 208** *C. stipata* **20, 124** *C. trichocarpa* **20, 21, 52, 85, 158, 184**	*Gaura biennis* 158 *Meriolix serrulata* 184 *Onagra biennis* (*Oenothera biennis*) 20, 21, 52, 66, 85, 124, 158, 184, 208
1906 1908 1910	*Puc. patruelis* Arth. (*P. Opizii* Arth. not Bubák)	*Carex pratensis* **136** *C. siccata* **185** *C.* sp. **85**	*Agoseris glauca* 136 *Lactuca canadensis* 85, 185 *L. sativa* 85, 185 *L. virosa* 85

Year	Rust	Telial host	Aecial host
1901 1902 1904 1905 1906 1908	*Puc. Sambuci* (Schw.) Arth. (*P. Atkinsoniana* Diet., *P. Bolleyana* Sacc.)	*Carex Frankii* **85** *C. lupulina* **65** *C. lurida* **21**, **124** *C. trichocarpa* **14**, **21**, **52**	*Sambucus canadensis* **14**, **21**, 52, 65, 85, 124
1904 1905	*Puc. Polygoni-amphibii* Pers.	*Polygonum emersum* 53, **69**, **53**	*Geranium maculatum* **53**, 69
1910	*Puc. argentata* (Schultz) Wint.	*Impatiens aurea* 189	*Adoxa Moschatellina* **189**
1909	*Urom. Andropogonis* Tracy	*Andropogon virginicus* **163**	*Viola cucullata* 163
1902 1917	*Urom. seditiosus* Kern (*U. Aristidae* Auth. not E. & E.)	*Aristida basiramea* **279** *A. oligantha* **23**	*Plantago aristata* 279 *P. lanceolata* 279 *P. Rugelii* 23
1916	*Urom. Sporoboli* E. & E.	*Sporobolus virginaeflorus* 274	*Allium stellatum* **274**
1915	*Urom. Hordei* Tracy	*Hordeum pusillum* **263**	*Nothoscordium striatum* 263
1911	*Urom. Peckianus* Farl.	*Distichlis spicata* **209**	*Atriplex hastata* 209
1905 1907 1909 1910 1912 1917	*Urom. Polemonii* (Peck) Barth. (*U. acuminatus* Arth., *U. Spartinae* Farl., *U. Steironematis* Arth., *U. magnatus* Arth.)	*Spartina Michauxiana* **76**, **106**, 164, **198**, **236**, **282**	*Collomia linearis* 236 *Polemonium reptans* 198 *Polygonatum biflorum* 282 *P. commutatum* 282 *Steironema ciliatum* 76, 106, 164 *S. lanceolatum* 164 *Vagnera stellata* 282
1906 1907 1908 1914	*Urom. Scirpi* (Cast.) Burr.	*Scirpus fluviatilis* **89**, **106**, **128**, **242**	*Cicuta maculata* 89, 106, 128 *Sium cicutaefolium* 242
1903 1910 1912 1914 1917	*Urom. perigynius* Halst. (*U. Solidagini-Caricis* Arth.)	*Carex deflexa* **190** *C. intumescens* **190**, **234** *C. sparganioides* **279** *C. tribuloides* **242** *C. varia* **37**	*Aster ericoides* 190 *A. paniculatus* 190, 234 *A. Tweedyi* 242 *Rudbeckia laciniata* 279 *Solidago caesia* 37 *S. canadensis* 37, 234 *S. flexicaulis* 37 *S. serotina* 37 *S. rugosa* 190

Year	Rust	Telial host	Aecial host
1910 1912	*Urom. Junci* (Desm.) Tul.	*Juncus balticus* **191, 236**	*Ambrosia artemisiaefolia* 191 *A. psilostachya* 191 *A. trifida* 191 *Carduus Flodmanii* 191, 236
1906 1907	*Urom. Silphii* (Syd.) Arth.	*Juncus tenuis* **92, 106**	*Silphium perfoliatum* 92, 106
1908	*Urom. houstoniatus* (Schw.) Sheldon	*Sisyrinchium gramineum* 129	*Houstonia caerulea* **129**
1908 1911	*Gym. Libocedri* (P. Henn.) Kern	*Libocedrus decurrens* **143, 211**	*Amelanchier vulgaris* 211 *Crataegus cerronis* 211 *C. Pringlei* 143 *C. tomentosa* 211
1907 1911	*Gym. inconspicuum* Kern	*Juniperus utahensis* **113, 211**	*Amelanchier erecta* 113 *A. vulgaris* 211
1909	*Gym. exiguum* Kern	*Juniperus virginiana* **169**	*Crataegus Pringlei* 169
1908 1910	*Gym. Davisii* Kern	*Juniperus sibirica* **132, 194**	*Aronia arbutifolia* 194 *A. nigra* 132, 194
1906 1907 1908 1910	*Gym. juvenescens* Kern	*Juniperus scopulorum* **93, 107, 130** *J. virginiana* **195**	*Amelanchier canadensis* 93, 107 *A. erecta* 107, 130, 195 *A. intermedia* (*A. Botryapium*) 107 *Sorbus americana* 93, 107, 130
1911	*Gym. Kernianum* Bethel	*Juniperus utahensis* **216**	*Amelanchier vulgaris* 216
1909	*Gym. trachysorum* Kern	*Juniperus virginiana* **172**	*Crataegus cerronis* 172 *C. coccinea* 172 *C. punctata* 172
1908 1914	*Gym. Botryapites* (Schw.) Kern	*Chamaecyparis thyoides* **131, 242, 243**	*Amelanchier canadensis* 242, 243 *A. intermedia* 131
1907 1909 1910 1911 1914	*Gym. nidus-avis* Thax.	*Juniperus virginiana* **108, 129, 165, 194, 210, 242**	*Amelanchier erecta* 210 *A. vulgaris* 194, 242 *Crataegus Pringlei* 165 *Cydonia vulgaris* 194 *Malus coronaria* 129, 210 *M. Malus* 108, 129 *M. ioensis* 165

Year	Rust	Telial host	Aecial host
1907 1908 1909 1910	*Gym. clavipes* C. & P.	*Juniperus sibirica* **107, 164, 193** *J. virginiana* **130**	*Amelanchier erecta* 107, 164, **193** *A. intermedia* 107 *Crataegus punctata* 164 *C. tomentosa* 193 *C.* sp. 130
1908 1909 1910	*Gym. cornutum* (Pers.) Arth.	*Juniperus sibirica* **131, 165, 194**	*Sorbus americana* 131, 165, 194 *S. aucuparia* 165
1908 1909	*Gym. exterum* Arth. & Kern	*Juniperus virginiana* **144, 166**	*Porteranthus stipulatus* 144, 166
1911	*Gym. juniperinum* (L.) Mart. (*G. tremelloides* Hartig)	*Juniperus sibirica* **211**	*Sorbus americana* 211
1911 1912	*Gym. gracilens* (Peck) Kern & Bethel	*Juniperus monosperma* **217** *J. utahensis* **237**	*Philadelphus coronarius* 217, 237 *P. Keteleerii* 237
1911	*Gym. effusum* Kern	*Juniperus virginiana* **217**	*Aronia arbutifolia* 217
1907 1908 1910 1911 1913	*Gym. clavariaeforme* (Jacq.) DC.	*Juniperus sibirica* **108, 130, 194, 210, 238**	*Amelanchier erecta* 130, 194, 210 *A. intermedia* 108 *Crataegus cerronis* 238 *C. punctata* 194
1914	*Gym. Ellisii* (Berk.) Farl.	*Chamaecyparis thyoides* **246**	*Myrica cerifera* 246
1907 1908 1909 1910 1912	*Gym. Betheli* Kern	*Juniperus scopulorum* **112, 113, 131, 165, 195, 237**	*Crataegus cerronis* 165, 195 *C. coccinea* 112 *C. cordata* 113 *C. Pringlei* 237 *C. punctata* 112 *C.* sp. 131 *Sorbus americana* 112, 113, 131
1906 1907 1908 1909	*Gym. globosum* Farl.	*Juniperus virginiana* **90, 107, 130, 164**	*Crataegus coccinea* 164 *C. Pringlei* 90, 130 *Malus coronaria* 90 *M. Malus* (*Pyrus Malus*) 107 *Sorbus americana* 90
1911 1912	*Gym. Nelsoni* Arth.	*Juniperus scopulorum* **237** *J. utahensis* **215**	*Amelanchier canadensis* 237 *A. vulgaris* 215

Year	Rust	Telial host	Aecial host
1909	*Gym. corniculans* Kern	*Juniperus horizontalis* **170**	*Amelanchier canadensis* 170 *A. erecta* 170
1908 1909	*Gym. floriforme* Thax.	*Juniperus virginiana* **129, 166**	*Crataegus coccinea* 166 *C. punctata* 129
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Names in *italics* are synonyms.

Numbers in broad-faced type indicate successful cultures.

Numbers in square brackets refer to pages (1) where the common name is used for the species instead of the Latin name, or (2) where the name occurs but is not the species intended and not a synonym (*e.g., Anchusa officinalis* for *Lycopsis arvensis*), or (3) where the name does not occur but some other name not a synonym (the error being due to wrong identification, *e.g., Gymnosporangium Nelsoni* used for *G. juvenescens,* or to common but erroneous usage, *e.g., Spartina cynosuroides* for *S. Michauxiana*).

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PURDUE UNIVERSITY,
LAFAYETTE, INDIANA.

NOTES AND BRIEF ARTICLES

[*Unsigned notes are by the editor*]

Professor F. S. Earle spent the summer months at his home in western Cuba, but expects to return to Porto Rico in September.

Dr. H. E. Thomas has resigned his position at Cornell University to accept one with Professor Kern at Pennsylvania State College.

Dr. F. J. Seaver accompanied Dr. Britton to Trinidad last February and returned with a splendid collection of fungi, in which the parasitic forms especially are well represented.

Mr. Rush P. Marshall, formerly Pathological Inspector, Office of Investigations in Forest Pathology, has been engaged to work on the potato wart disease for the Federal Horticultural Board.

Dr. Alfred H. W. Povah has resigned as assistant professor of Forest Botany and Pathology in the New York State College of Forestry to accept the position of associate professor of Plant Pathology and associate pathologist at the Alabama Polytechnic Institute, Auburn, Alabama.

Mr. Paul V. Siggers has accepted the position of Pathologist for the United Fruit Company and will be stationed at Changuinola, Panama, investigating diseases of the cocoanut palm and cacao. He was formerly Scientific Assistant for the Office of Investigations in Forest Pathology.

Mr. E. J. Wortley has resigned his position as Director of Agriculture in Bermuda to accept a similar one in Nyasaland. Mr. E. A. McCallan, a native Bermudian and a graduate of the Ontario Agricultural College, succeeds him as Director at the Agricultural Station in Bermuda.

Professor A. de Jaczewski, of the Institut de Mycologie at Petrograd, is on a visit to the United States after being cut off from the outside world about six years. He called at the Garden August 11, shortly after his arrival, and expects to spend two months in various parts of the country.

JOHN MACOUN

Professor John Macoun, the distinguished Canadian naturalist, died July 18, 1920, at Sidney, British Columbia, at the advanced age of 89. He was born near Belfast, Ireland, and came to Canada in 1850 with his mother and two brothers. After preliminary scientific training in teaching, he was engaged for many years in botanical and zoological explorations in western Canada for the Canadian Government and at length became attached to the Geological and Natural History Survey. His scientific work covered a wide range, both in botany and zoology, and he was ably assisted by his son, the late James M. Macoun. Many of the plants collected by them are in the herbarium of the New York Botanical Garden.

W. A. MURRILL

At the request of naturalists generally throughout Canada, the Ottawa Field-Naturalists' Club has decided to receive subscriptions for a permanent memorial in honor of the late Professor John Macoun, who died on July 18, 1920. Many of his friends have thought that the memorial should take the form of a painted portrait to be hung in the Victoria Memorial Museum. Such a memorial has now been decided upon and the painting will be made by Mr. Franklin Brownell, of Ottawa, the well-known portrait painter. The expenses in connection therewith will be about $700. Subscriptions to this fund should be forwarded to Mr. Arthur Gibson, Dominion Entomologist, Ottawa, Canada.

EDWARD T. HARPER

Dr. Edward T. Harper died at his home in Geneseo, Illinois, January 14, 1921. He was born at Sabula, Iowa, September 28,

1857; graduated from Oberlin College in 1881 and from the Chicago Theological Seminary in 1887; took a Ph.D. degree in Semitics at Leipzig in 1891; received the honorary degree of D.D. at Iowa College in 1902 and Oberlin in 1908; and for nineteen years, from 1892 to 1911, held the chair of Semitics and Comparative Religion at the Chicago Theological Seminary. From the time he retired because of ill health until shortly before his death, he was actively engaged in botanical studies, and had always been an ardent lover of plants. His botanical collections, which have been deposited in the Field Museum at Chicago, include a very full series of superb photographs and stereoscopic views of the fleshy fungi. Readers of MYCOLOGIA will remember an article on *Hypholoma* contributed by him in 1918; while his handsomely illustrated papers on *Pholiota, Stropharia,* and *Hypholoma,* published in the *Transactions of the Wisconsin Academy of Sciences,* 1912–1914, are well known to all students of the gill-fungi. Dr. Harper's sustained activity in mycology and his success in this field were due in part to the sympathetic interest and help of his brother, Robert A. Harper, Professor of Botany in Columbia University.

W. A. MURRILL

A long list of Long Island fungi, prepared by Burnham and Latham, appeared as a "second supplementary list" in *Torreya* for January–February, 1921. Most of the species included belong to inconspicuous groups.

"The Fungal Diseases of the Common Larch," by W. E. Hiley, contains over 200 pages, 23 plates, and 28 figures. The work includes a discussion of the various larch diseases, a summary of the relations of the larch to its diseases, and an extensive bibliography.

Bacterial wilt of the castor bean forms the subject of a well-illustrated paper by E. F. Smith and G. H. Godfrey published in the *Journal of Agricultural Research* for May 16, 1921. Diseased plants were first received from Townsend, Georgia, where

the loss was sometimes as high as 30 per cent. The disease was later found at many points in Florida and elsewhere. The causal organism appeared to be *Bacterium solanacearum,* which attacks a number of different plants.

"A Handbook of British Lichens," by Annie Lorrain Smith, containing 158 pages of text and 90 text figures, has just been published by the British Museum. The object of the book is to supply a portable guide to the determination of lichens in the field. The 128 genera included are briefly described, while the species are distinguished by keys only. There is an introduction in which the morphology, ecology, etc., of lichens are discussed, and a glossary of the chief terms employed.

"Insects Injurious to Deciduous Shade Trees and Their Control," by Jacob Kotinsky, published as Farmers' Bulletin 1169 of the U. S. Department of Agriculture, is of interest to mycologists because of the close connection found to exist between insects and fungi when it comes to the treatment of diseases. In the gall-insects, which rarely affect the vitality of a tree, the connection between insect and host is exceedingly close. In one group the mother inserts an acid with the egg, but in all other groups it is the growth of the larva that provides the stimulus, the contact between the insect and the surrounding plant tissue being very intimate.

Last January I secured, near Greenville, South Carolina, several specimens which Dr. Burt, of the Missouri Botanical Garden, identified as *Tricholoma terreum.* One of the specimens which I kept in Greenville had been pierced by a pine needle. The other specimens kept well for a week or more, seeming to have the consistency of a *Russula,* but this pierced specimen rotted where the needle pierced it. Instead of the smell being objectionable it was sweet and would have made a good cologne odor. I do not know whether the fungus produced this odor from the pine needle or whether the needle caused the mushroom to give the odor. The needle was of the long variety peculiar, I believe, to the Piedmont section.—*E. D. Hallock*

On July 11 Mrs. John R. Delafield sent to the Garden, from her lawn in Riverdale, an unusually large specimen of *Grifola gigantea,* a polypore that grows in tufted form from buried roots, stumps, and about the base of trees, the mycelium being parasitic on the roots of oak and other deciduous trees in this region. This particular specimen measured two feet across and one foot in height and developed from a stump which had been cut off close to the ground. It was nearly white when young and fresh, becoming grayish on developing and smoky-blackish on drying. Another large fungus, *Grifola Berkeleyi,* similar in shape to *G. gigantea,* occurs about oak trees in the eastern United States, but may readily be distinguished by its creamy color and the lack of blackish tints on drying.

Spike disease of sandalwood in India has been discussed by several investigators in recent years. Some believe that it is caused by ultra-microscopic organisms, and perhaps disseminated by insects, while its spread from centers favors the infection theory. Experiments at Komattiyur and Andiappanur gave results entirely opposed to the theory that spike is caused by an unbalanced circulation of sap. Transmission of infection over the long distances observed has not been explained, however. Birds, insects, or flying foxes may act as carriers, but carriage through other plants is considered more probable. Spike develops more rapidly in some areas than in others, and is more rapid in seedlings and saplings than in older trees. May to July is the most favorable portion of the year for its extension. Spike does not progress regularly from branch to branch. The preventive measures proposed include mainly isolation and destruction of the trees infected.

The North American species of *Stereum* were discussed by E. A. Burt in the *Annals of the Missouri Botanical Garden* issued in December, 1920. Seventy-seven species are recognized in this difficult genus, while several are imperfectly known and many now belong in *Aleurodiscus, Thelephora,* etc. The main divisions of the genus are based on the presence or absence, or

attachment of the stipe, but these differences are not considered sufficient to divide the genus. Five thickly crowded half-tone plates add greatly to the value of this excellent paper of 160 pages of text and 48 text figures.

Species described as new in this paper are as follows: *Stereum caespitosum,* Jamaica, *Murrill; S. saxitas,* Mexico, *Murrill*—also Jamaica, *Johnson; S. pubescens,* Montana, *Mrs. Fitch; S. conicum,* Cuba, *Wright; S. patelliforme,* Washington, *Suksdorf*—also California and New Mexico; *S. Earlei,* Jamaica, *Earle; S. magnisporum,* Jamaica, *Murrill; S. spumeum,* New York, *Burnham*—also Pennsylvania, South Carolina, Louisiana, and Mexico; *S. erumpens,* District of Columbia, *Shear*—and known to occur from Rhode Island to Alabama and west to Washington and Oregon; *S. sepium,* Georgia, *Humphrey*—and known to occur from Pennsylvania to Mexico and Colombia; *S. heterosporum,* Mexico, *Matthews*—and known on the Pacific coast as far northward as Oregon; and *S. durum,* Mexico, *C. L. Smith.*

In Bulletin 933 of the U. S. Department of Agriculture, on Black Walnut, by F. S. Baker, the following statement is made regarding the diseases caused by fungi:

Black walnut is moderately free from tree diseases and is as resistant to injury as any of its associates. Red butt rot is found in a small percentage of trees, mostly old trees of northern growth, although it is very bad in parts of central Kentucky. As a rule the rot extends only a short distance up the tree, and "butting off" the lower 3 or 4 feet of a hollow tree will usually remove most of this defect. The "doty" zone that surrounds the advanced decomposition at the center is generally narrow; it is frequently possible, in fact, to saw boards within an inch of an open hollow before any discoloration appears.

A white top rot is found, limited almost entirely to southern logs, particularly from Oklahoma and Texas. Its presence is indicated by punky knots and occasionally by conks on the upper trunk. This rot extends a greater distance up and down the trunk than the red butt rot and is a much greater detriment to

the logs, especially if they are to be used for sawing into lumber. A large log with a defective center might be made to furnish a large amount of first-class veneer, but could not to advantage be sawed into lumber.

The relation of the health of the host and other factors to infection of *Apium graveolens* by *Septoria Apii* is discussed at length by H. E. Thomas in the *Torrey Bulletin* for January, 1921. According to the author, "students of immunity and susceptibility have been slow to recognize any fundamental distinctions in the relations of host and parasite in the great group of organisms which cause disease in plants and animals, and yet the concepts of saprophyte, semi-saprophyte, and obligate parasite have been current at least since the time of DeBary. Under the influence perhaps chiefly of Ehrlich's side chain theory of immunity, degrees of resistance have been regarded on the one hand as inversely parallel to the virulence of the attacking organism, and on the other hand as directly parallel to the vigor of the host. In plant pathology this view has been particularly prominent in the literature of the facultative parasites. With the development of the science of immunity, the animal pathologist has gone so far as to regard the interactions of host and parasite as specific in each case. It is becoming increasingly apparent that the specificity in the relation of plant pathogens with their hosts must be reckoned with. The saprophytic fungus may be able to live on dead tissue from a wide range of plants, sometimes showing little preference for any one of them. The semi-saprophyte may or may not be more limited in its food range on dead material and attacks from one to a considerable number of living plants with varying degrees of virulence and with variable results to the hosts. The obligate parasite is usually still more restricted in its host range and is much more closely adapted to the living host, having completely lost the ability to grow on dead tissue, even that of its most common host. In the more highly specialized forms the relation may become specific to such a degree that a comparatively slight change in either host or fungus will completely change the virulence of the parasite or the effect on the

host. It is to be expected, after the long period of association necessary for the close adaptation of fungus to host, that both would be more or less similarly influenced by their environmental conditions. I shall present data to show that the infection of *Apium graveolens* by *Septoria Apii* is favored by conditions which accelerate the growth of the host. The comparatively narrow specialization of the *Septoria* on celery suggests a promising outlook for experiments in breeding for resistance. More intensive work in this direction is needed."

IS AMANITA PANTHERINA EDIBLE OR POISONOUS?

It will interest mycologists to note that Dr. Raebiger[1] has experimented toxicologically with *Amanita pantherina,* a species usually regarded with fear. Raebiger fed the plant raw to guinea pigs, while rabbits were given material, in part raw, in part cooked. Two goats and two pigs were supplied with daily rations of ten German pounds of parboiled material for a period of six weeks. In the case of the pigs, other poisonous and suspicious species were included in the rations. In none of these animals was it possible to observe any impairment of their health.

The author states further that he has for years gathered this species for his own consumption without experiencing the slightest poisonous effects. He admitted no other species into his messes of *A. pantherina,* and, before cooking, would remove the cuticle of the pileus, the "cortex" of the stem, and then parboil, throwing away the water.

We know that edibility for this species, after preliminary precautions such as Dr. Raebiger took, has been claimed by Michael,[2] who says that it is excellent, cooked, or as a pickle. Ford[3] regards it as mildly poisonous. Inoko[4] and Boehm[5] have made

[1] Raebiger, Dr., Zur Kenntnis der Gift und Nutzpllze. Berliner klin. Wochenschrift, No. 38. 1919.

[2] Michael, E., Fuehrer fuer Pilzfreunde. Ausgabe 'B,' Gruppe 76. 1918.

[3] Ford, W. W., The Distribution of Poisons in the Amanitas. Jour. of Pharm. and Exper. Therap., Vol. I, No. 2, p. 277. Aug. 1909; and, A Clinical Study of Mushroom Intoxication. The Johns Hopkins Bull., XVIII, No. 193, pp. 124 (14) and 129 (20). April, 1907.

[4] Inoko, Y., Ueber die giftigen Bestandtheile und Wirkungen des Japan-

rather exhaustive chemico-toxicological examinations. *Amanita pantherinoides* Murrill, a related species, "was eaten by two persons with almost fatal results."[6]

With several European forms, a Japanese form, with our own more or less closely allied species (*A. cothurnata* Atk., *A. velatipes* Atk., and *A. pantherinoides* Murrill), and with the umbrinous form of *A. muscaria* entering into the complex all too frequently called "A. pantherina," it would appear that results, in a toxicological examination of this "species," are likely to prove inconclusive unless considerable systematic acumen is permitted to supervene.

L. C. C. KRIEGER

ischen Pantherschwammes. Mittheil. aus der Medic. Fac. der Kaiserl. Jap. Univ., Tokio, Bd. I, No. 3, pp. 277–306. 1889; and No. 4, pp. 313–331. 1890.

[5] Boehm, R., Beitraege zur Kenntnis der Hutpilze in Chemischer und toxicologischer Beziehung . . . . II. *Amanita pantherina.* Archiv fuer exper. Pathol. u. Pharmac. v. Naunyn u. Schmeideberg, XIX. 1885, p. 60; see also Berichte d. Deutsch. Chem. Gesell., XIX. 1886. Refer. p. 34.

[6] Murri", W. A., in Mycologia 10: 289. Nov., 1918.

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MYCOLOGIA

VOL. XIII NOVEMBER, 1921 No. 6

A CONTRIBUTION TO OUR KNOWLEDGE OF THE PYRENOMYCETES OF PORTO RICO[1]

CARLOS E. CHARDON

(WITH PLATES 13–15, AND TEXT FIGURES 1–4)

The study of the fungous flora of Porto Rico has received in recent years considerable attention from American mycologists. Their enthusiasm has been stimulated by the extensive collections made by Stevens, Fink, Whetzel and Olive, and has led to the publication of a series of papers which give us some conception of the richness of the mycological flora of the island. These studies are of importance, since they represent the first attempt on the part of American mycologists to gain a clearer knowledge of the fungi of the West Indies. A fairly complete account of the Uredinales has been presented in the publications of Arthur (2, 3) and Whetzel and Olive (22), but our knowledge of the pyrenomycetes is still far from perfect in spite of the numerous papers which have appeared dealing with the members of this group.

Klotzch and Sintenis seem to have been the first botanists to collect these fungi on the island and a list of their collections has appeared in literature (18, 26). Heller, in 1900, collected in quantity members of the group and distributed them in his Plants of Porto Rico. His specimens were studied by Earle, who published on them two papers (7, 8), which were the first contributions of importance. A number of years followed in which no

[1] Also presented to the Faculty of the Graduate School of Cornell University as a major thesis in partial fulfillment of the requirements for the degree of Master of Science.

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further progress was made, but in 1913 a very active phase of the work was initiated by Stevens and has steadily progressed up to the present time. During 1913–15 Stevens made extensive collections of fungi and accumulated a large amount of material which is deposited at the herbarium of the University of Illinois. He has studied his collection in collaboration with some of his students, and they have published a number of papers on the pyrenomycetes (16, 21, 28, 29, 30, 31, 32, 33, 34, 35) in which a great number of new species have been described. Whetzel and Olive spent the spring of 1916 in the island collecting rusts and other parasitic fungi. A few of the pyrenomycetes of their collections have been described by Fitzpatrick (13, 14) and Seaver (25), and recently a list of all of them was published by the writer (6). A third extensive collection, consisting chiefly of lichens and ascomycetes, was made by Fink in the winter of 1915–16, but nothing has been published on it, excepting a preliminary note by him (12). However, a set of his collections has been sent to the writer, and a further study of them will certainly disclose a number of interesting forms. The pathologists at the Insular Experiment Station at Rio Piedras, P. R., have given a generous part of their time to the collection of fungi and their specimens are deposited at the Station Herbarium. A number of their pyrenomycetes have been sent to Seaver for identification.

Stevenson's "Check List of Porto Rican Fungi" (36), which is a compilation of all the species previously reported and widely scattered in literature, appeared in 1918. It constitutes a starting point for the study of the fungous flora of the island. This paper is rapidly going out of date, however, and the necessity for its revision is felt.

The writer, having become interested in the study of the pyrenomycetes, spent the summer of 1920 in the island collecting intensively on this group. Also the collections of Whetzel and Olive, Stevens, Fink and those of the Insular Experiment Station have been available to him. A close study of these has brought out a sufficient number of interesting facts to warrant the publication of this paper. It represents an attempt toward a more complete understanding of the insular forms of the group.

The writer wishes especially to acknowledge his obligation to Doctor F. J. Seaver and Doctor W. A. Murrill of the New York Botanical Garden for their courtesy and kindness during two brief visits there; to Mr. E. D. Colón, Director of the Insular Experiment Station, and to Mr. J. Matz and Mr. B. López, of the Plant Pathology staff, for their coöperation in connection with this work; to Doctor B. Fink, of Miami University, for having generously sent a set of his collections to the writer; to Doctor F. L. Stevens, of Illinois University, and Doctor C. R. Orton, of Pennsylvania State College, for courteous advice in correspondence. Thanks are due also to Doctor C. Ferdinandsen and Doctor C. Christendsen, of the University of Copenhagen, Denmark; to Doctor L. Romell, of the Royal Museum at Stockholm, Sweden, and to Doctor C. Spegazzini, of LaPlata, Argentine, for having supplied the writer with portions of type materials for examination in connection with this work. Finally, an expression of appreciation is due to Professor H. H. Whetzel, of the Department of Plant Pathology, Cornell University, for placing at the writer's disposal all of his collections, and to Professor H. M. Fitzpatrick, of the same department, under whose supervision the work has been conducted, for valuable suggestions and coöperation, and for the revision and correction of the manuscript. Thanks are also due to Mr. W. R. Fisher for the care taken in the preparation of the photographs which illustrate this paper.

PERISPORIALES

MICROTHYRIACEAE

Lembosia Lév.

This genus founded by Léveillé (19) was based on four species: *Lembosia tenella, L. macula, L. Drymidis* and *L. Dendrochili.* Theissen (37) in his recent monograph considers *L. tenella* as the type of the genus and creates a number of additional genera, retaining in the old genus *Lembosia* only those forms having a superficial mycelium and paraphyses. He has reduced to synonymy two Porto Rican species described by Earle (7, 8). It is in the sense of Theissen that the genus is considered here.

The affinities of the genus are not well understood. Saccardo (23), Lindau (20) and Ellis and Everhart (9) have placed it in the Hysteriaceae, while Spegazzini (27) included it in the Hemihysteriaceae. Gaillard (15) first threw light on its real affinities. He shows that the formation of perithecia takes place very much as in *Asterina* and suggests that the genus be incorporated in the Microthyriaceae. Theissen and Sydow (40) definitely include it under that family.

KEY TO PORTO RICAN SPECIES

A. Colonies inconspicuous; spores small, 8–11 μ long. *L. microspora*
B. Colonies very conspicuous, spores larger.
  1. Spores 28–35 μ long. *L. melastomatum*
  2. Spores 16–20 μ long.
    a. Hyphopodia present; on *Coccoloba*. *L. tenella*
    b. Hyphopodia absent; on *Agave*. *L. Dendrochili*

Lembosia microspora sp. nov.

Colonies inconspicuous; mycelium very sparse, widely effused, hyphae septate at regular intervals, brown, 3–4 μ in diam., occasionally branched and anastomosing; hyphopodia absent; ascomata epiphyllous, scattered, black, very rarely confluent, linear, straight or more often curved, ends obtuse, 250–750 x 100–180 μ, in rare cases exceeding 1 mm. in length; asci ellipsoidal to subglobose, 8-spored, 19–23 x 10–13 μ; spores inordinate, rather unequally septate, hyaline, becoming dark brown at maturity, 8–11 x 4–5 μ; paraphyses inconspicuous (figs. 1–3).

Differs from all other known species of *Lembosia* in the small size of the spores. Another prominent feature is the inconspicuous character of the colonies due to the very scant development of mycelium.

MATERIAL EXAMINED:

On *Ocotea leucoxylon* (Sw.) Mez. (with an undetermined microthyriaceous form on the under surface of the leaf). Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 621, Maricao, Mar. 16, 1916 (*type*).

LEMBOSIA MELASTOMATUM Mont., Pl. Cellul. Cent. VII: 373.

Lembosia diffusa Winter Hedwigia **24**: 30. 1885.

The Porto Rican collections of this form have all been reported

as *L. diffusa*. The spore measurements given by different authorities vary. Ours, 26–33 x 11–14 μ, seem to agree with those of Arnaud (1) (figs. 4–6).

MATERIAL EXAMINED:

On *Miconia prasina* (Sw.) DC. Porto Rican fungi (Fink), No. 587, Rio Piedras, Dec. 2, 1915; Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 665, Maricao, Mar. 23, 1916.

LEMBOSIA TENELLA Léveillé, Ann. Sci. Nat. III (Bot.) 3: 58. 1845.

Lembosia Coccolobae Earle, N. Y. Bot. Gard. Bul. 3: 301, 302. 1903.

Theissen (37) has examined a portion of Earle's type and says: "Nach dem Blatt zu urteilen, ist die Matrix genau derselbe wie die Nicaragua-Exemplar von *Lembosia tenella;* der Pilz ist derselbe, die Art also synosym mit der von uns adoptierten Form von tenella" (figs. 7–8).

The species seems to be of common occurrence. It is unique in being able to withstand the most xerophytic conditions. The spores measure 15–21 x 6–7 μ.

MATERIAL EXAMINED:

On *Coccoloba uvifera* (L.) Jacq. Plants of Porto Rico (Heller), No. 6375, Santurce, Jan. 7, 1903 (*type*); Cornell University Explorations of Porto Rico (Whetzel & Olive), Nos. 522, 523, Mayaguez, Mar. 3, 1916; id. id. (Chardon), No. 836, Ponce, Sept. 6, 1920.

LEMBOSIA DENDROCHILI Léveillé, Ann. Sci. Nat. III (Bot.) 3: 59. 1845.

Lembosia Agaves Earle, Muhlenbergia 1: 15. 1900.

A characteristic species on account of its numerous black spots, which are slightly elevated. Earle's material is not fully matured, and he gives the spore measurements as 14–16 x 6–7 μ. Ferdinandsen and Winge (11) examined ripe material from Trinidad

and found the spores to measure 17–20 x 7–9 μ. The material collected by the writer does not show spores, but it is undoubtedly this species. Thiessen considers Earle's species to be identical with *L. Dendrochili.*

MATERIAL EXAMINED:

On *Agave* sp. Plants of Porto Rico (Heller), No. 4429, Cabo Rojo, Jan. 29, 1900 (*type*); Cornell University Explorations of Porto Rico (Chardon), No. 837, Penuelas, July 20, 1920.

HYPOCREALES

The system of Seaver (24) will be followed in this order.

NECTRIACEAE

HYPONECTRIA PHASEOLI Stevens, Bot. Gaz. **70**: 401. 1920.

Phyllachora Phaseoli P. Henn, *in* Chardon Mycol. **12**: 320. 1920.

The collection of this fungus previously reported by the writer as *Phyllachora* agrees perfectly with the description of Stevens's species.

MATERIAL EXAMINED:

On *Phaseolus adenanthus* Meyer. Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 659, Tamana River, Apr. 7, 1916.

CREONECTRIA OCHROLEUCA (Schw.) Seaver, Mycol. **1**: 190. 1909.

? *Creonectria grammicospora* (Ferd. & Wge.) Seaver, *in* Chardon Mycol. **12**: 319. 1920.

This species resembles *Creonectria Bainii* (Massee) Seaver in perithecial, ascus and spore characters; it differs in that the perithecia are flesh colored when young. The color soon changes to light yellow, and then it becomes impossible to tell the two apart. *Creonectria grammicospora* (F. & W.) Seaver is probably identical with *Creo. ochroleuca,* or represents a variety of it, but definite action in regard to this point can not be taken until the type materials of both species have been examined.

MATERIAL EXAMINED:

On dead bark and twigs. Porto Rican Fungi (Fink), No. 1135, Mayaguez, Dec. 21, 1915; Cornell University Explorations of Porto Rico (Whetzel & Olive), Maricao, Mar. 23, 1916, deposited in Chardon herbarium as No. 742; id. id. (Chardon), No. 888, Penuelas, July 20, 1920.

CREONECTRIA RUBICARPA (Cooke) Seaver, Mycol. 1: 187. 1909.

Nectria rubicarpa Cooke, Grevillea 7: 50. 1878.

The material examined, although scant, seems to agree with this species except in one character: the arrangement of the perithecia in cespitose clusters is not pronounced. Most of them are gregarious. The spores measure 10.5–12 x 5–6 μ.

MATERIAL EXAMINED:

On a log. Porto Rican Fungi (Fink), No. 215, Rio Piedras, Jan. 18, 1916; Cornell University Explorations of Porto Rico (Chardon), No. 889, Mayaguez, July 14, 1920.

Ophionectria portoricensis sp. nov.

Perithecia densely gregarious, cylindrical to subconical, slightly tapering above, 500–800 μ high, 250 μ in lateral diameter, scarlet, covered irregularly with a mealy substance which gives a warty appearance, naked toward the apex, possessing a distinct ostiolum, 15 μ in diam.; asci subcylindrical, tapering above and below, 217–274 x 22.5–28 μ, 8-spored, the ascus wall evanescent; spores filiform, curved, slightly tapering toward each end, contents hyaline and granular, 13–27 septate, 153–221 x 6–7.5 μ; paraphyses indistinct.

A very distinct and characteristic species on account of the unusually large spores and asci (fig. 10).

MATERIAL EXAMINED:

On a log. Cornell University Explorations of Porto Rico (Whetzel & Olive), Mayaguez, Mar. 13, 1916, deposited in Cornell University Department of Plant Pathology herbarium as No. 11129 (*type*).

HYPOCREACEAE

Podostroma orbiculare sp. nov.

Stromata stipitate or substipitate, orbicular, convex, yellowish brown, white and woody within, 4–6 mm. in diam., 2–3.5 mm. high, the surface minutely rugulose from the slightly protruding ostiola; stem stout, short, not exceeding 2 mm. in diam.; perithecia entirely immersed in the stroma, 120–180 μ in diam.; asci cylindrical, 50–60 x 4 μ, becoming 16-spored at maturity; spores subglobose, hyaline, 2.5 x 3 μ; paraphyses present (fig. 11).

This beautiful species is unique in having a woody stroma instead of the fleshy or subfleshy stroma common to this and other allied genera. It is placed in *Podostroma* rather than in *Hypocrea,* since the stroma is stipitate.

MATERIAL EXAMINED:

On a decaying log. Porto Rican Fungi (Fink), No. 239, Mayaguez, Dec. 17, 1915 (*type*).

STILBOCREA HYPOCREOIDES (Kalch. & Cooke) Seaver, Mycol. **2**: 62. 1910.

? *Stilbocrea intermedia* Ferd. & Wge., Bot. Tidsk. **29**: 12. 1908.

This species is very closely related to *S. intermedia,* from which it can, in fact, hardly be distinguished. Seaver (**24**) separates the two forms on the basis of spore measurements, but the difference is so slight as to raise the question whether the two may not be identical.

MATERIAL EXAMINED:

On bark and decaying wood. Herbarium Insular Experiment Station (Stevenson), No. 2390, Rio Piedras, Nov. 29, 1914; Cornell University Explorations of Porto Rico (Chardon), No. 1237, Mayaguez, July 14, 1920.

Dothichloe Atk.

This genus comprises a few forms parasitic on grasses. It was erected by Atkinson (**4, 5**) to include those species of *Hypocrella* possessing a dothideaceous stroma like *Dothichloe atramentosa* (B. & C.) Atk.

The systematic position of the genus is not definitely established. It is included in the Hypocreales by Seaver (24) as a synonym of *Balansia*. Since Seaver does not discuss any of the species of *Dothichloe* under *Balansia,* there appears to be no justification for this. *Dothichloe* is distinct from *Balansia* in not possessing a pseudosclerotium made up of a mixture of host and fungous tissue. Theissen and Sydow (39) exclude the genus from the Dothideales and regard it as identical with *Ophiodothis*. Stevens in his "Fungi Which Cause Plant Disease" assigns it a definite place in the Hypocreales, placing it next to *Balansia*. The writer has examined a set of prepared slides made from the type specimen of *Hypocrea atramentosa* B. & C. which are deposited in the Atkinson herbarium at Cornell University. The stroma is evidently dothideaceous and no evidence of a perithecial wall is present. However, in their filiform spores and in certain other minor characters the species show marked resemblance with those of *Balansia, Epichloe* and *Hypocrella,* and thus a relationship with the Hypocreaceae is strongly suggested.

KEY TO PORTO RICAN SPECIES

A. Stromata distinct, subglobose, located below the nodes of the host. *D. subnodosa*

B. Stromata broadly effused.

1. Stromata completely encircling the culms. *D. Aristidae*
2. Stromata borne on the leaf and occupying only one side. *D. atramentosa*

Dothichloe subnodosa sp. nov.

Balansia subnodosa Atk., in mss.

Dothichloe nigricans (Speg.) Seaver, *in* Stevenson, Jour. Dept. Agr. Porto Rico 2: 151. 1918.

Stromata subglobose, slightly flattened, located just beneath the nodes on the culms of the host, partially or in rare cases entirely surrounding the host, black, brown or yellowish within, not united with the host elements, 1–3 mm. in diam., with the surface rugulose from the papillate ostiola; locules immersed, flask-shaped, 125–150 x 150–200 μ; asci narrowly cylindrical, tipped with a globose "cap cell," 150–180 x 3–4.5 μ, 8-spored; spores filiform, nearly as long as the asci, approximately 1 μ broad, fragmenting at maturity; paraphyses present (fig. 14).

This fungus is clearly different from *Epichloe* ? *nigricans* Speg., which has stromata 5–10 mm. long. Atkinson worked with one of Stevens's collections of this form and labeled it in his herbarium

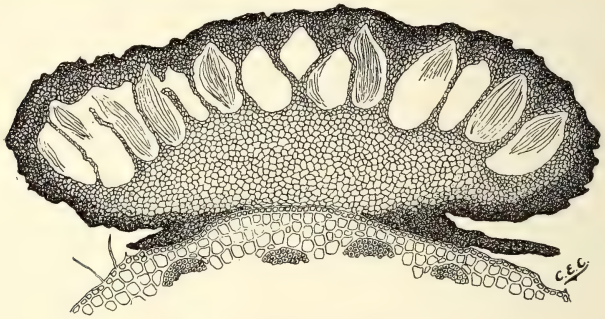

FIG. 1. *Dothichloe subnodosa* sp. nov. Cross section of a stroma showing the sharp definition between the host and fungous tissue. (Outlined with a camera lucida; × 50).

as "*Balansia subnodosa* sp. nov." He apparently, however, never published it. The writer feels that the species should be transferred to *Dothichloe* on account of the absence of the intimate fusion of fungous and host tissue, pseudosclerotium, characteristic of *Balansia*.

MATERIAL EXAMINED:

On *Ichnanthus pallens* Munro. Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 690, Mayaguez, Mar. 6, 1916 (*type*); id. id. (Whetzel & Olive), No. 689, Mayaguez, Mar. 2, 1916; id. id. (Whetzel & Olive), No. 692, Maricao, Mar. 22, 1916; id. id. (Whetzel & Olive), No. 691, El Yunque, Apr. 22, 1916.

DOTHICHLOE ARISTIDAE Atk., Bul. Torr. Bot. Club **21**: 224. 1894.

Characteristic in that the stroma completely surrounds the culms of the host, as in *Epichloe*. However, the stromata are black and carbonaceous (fig. 13).

MATERIAL EXAMINED:

On *Aristida portoricensis* Pilger. Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 695, Mayaguez, Mar. 7, 1916.

DOTHICHLOE ATRAMENTOSA (B. & C.) Atk., Jour. Mycol. **11**: 260. 1905.

Hypocrea atramentosa B. & C., Jour. Linn. Soc. **10**: 377. 1869.

Stromata 5–15 mm. long, black, carbonaceous, occupying only one side of the leaf. Very distinct from the preceding species (fig. 12).

MATERIAL EXAMINED:

On *Andropogon leucostachys* H. B. K. Herbarium University of Illinois, Porto Rican Fungi (Stevens), No. 8211, Las Marias, July 10, 1915.

On *Chloris petraea* Sw. Cornell University Explorations of Porto Rico (Whetzel & Olive), Nos. 694, 694*a*, Boqueron, Mar. 11, 1916.

DOTHIDEALES

The system of Theissen and Sydow (39) will be followed here in its entirety.

DOTHIDEACEAE

Dothidina peribebuyensis (Speg.) comb. nov.

Phyllachora peribebuyensis Speg., Fung. Guar. **1**: 274. 1883.

Auerswaldia Miconiae P. Henn., Hedwigia **43**: 253. 1904.

Bagnisiopsis peribebuyensis (Speg.) Th. & Syd., Ann. Mycol. **13**: 292. 1915.

Dothidina Miconiae (P. Henn.) Th. & Syd., Ann. Mycol. **13**: 298. 1915.

A comparison of the type material of *Phyllachora peribebuyensis* Speg. (Balansa—Plantes du Paraguay No. 3854) and that of *Auerswaldia Miconiae* P. Henn. (Ule—Appendix Mycotheca Brasiliensis No. 27) has shown them to be the same fungus. Theissen and Sydow seem to have overlooked this fact and have proposed new combinations for each, placing them under different genera.

The fungus is by no means a *Phyllachora*. Garman (16) identified the specimens collected by Stevens as *P. peribebuyensis*, but admitted that the species might possibly fall under *Bagnisiopsis*. Working with material from Colombia, H. and P. Sydow (41) also made the mistake of referring the fungus to *P. peribebuyen-*

sis. They observed, however, that the spores at maturity turn to a light brown color, which suggested to them the genus *Auerswaldia*. Finally Seaver determined the specimens collected by Whetzel and Olive as *Auerswaldia Miconiae* and the writer (6) published them under that name (fig. 19).

The fungus falls under *Dothidina* in the treatment of Theissen and Sydow on account of the presence of paraphyses. The spores measure 14–18 x 6–7 μ.

MATERIAL EXAMINED:

On *Heterotrichum cymosum* (Wendl.) Urban. Herbarium University of Illinois, Porto Rican Fungi (Stevens), No. 5206, San Sebastian, Nov. 13, 1913; Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 643, El Yunque, Apr. 12, 1916.

On *Miconia laevigata* (L.) DC. Herbarium University of Illinois, Porto Rican Fungi (Stevens), No. 435, El Gigante, Dec. 15, 1913.

On *Miconia prasina* (Sw.) DC. Herbarium Insular Experiment Station (Stevenson), No. 5362, Espinosa, Mar. 27, 1917.

On *Miconia Sintenisii* Cogn. Herbarium University of Illinois, Porto Rican Fungi (Stevens), No. 6656, Santa Ana, Dec. 31, 1913.

On *Miconia* sp. Herbarium Insular Experiment Station (Stevenson), No. 742, Maricao, Mar. 14, 1913; Cornell University Explorations of Porto Rico (Whetzel & Olive), Nos. 696, 697, Maricao, Mar. 22 and 15, 1916, respectively.

On *Tetrazygia elaeagnoides* (Sw.) DC. Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 636, Barceloneta, Apr. 8, 1916.

PHYLLACHORACEAE

Trabutia Bucidae sp. nov.

Spots not exceeding the stromata; stromata numerous, hypophyllous, crowded in irregular areas 5–10 mm. in diam., individual stromata black, shining, approximately circular, often confluent, .5–1.5 mm. in diam., subcuticular; locules globose to oblong, 200–300 x 150–200 μ, covered by a well-developed stroma which often

extends far beyond them; asci very indistinct, clavate cylindrical, 8-spored, 50–64 x 17–24 μ; spores inordinate, continuous, pale yellow, globose to ellipsoidal, 9–12 x 7–8 μ; paraphyses present, profuse (fig. 22).

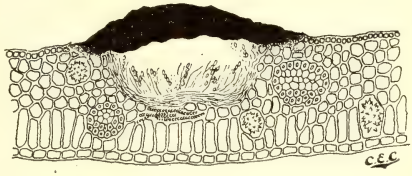

FIG. 2. *Trabutia Bucidae* sp. nov. Cross section of a leaf of *Bucida buceras* showing a locule covered above with a subcuticular stroma. (Outlined with a camera lucida; × 125).

MATERIAL EXAMINED:

On *Bucida buceras* L. Cornell University Explorations of Porto Rico (Chardon), No. 905, Coamo, Aug. 21, 1921 (*type*).

Trabutia Guazumae sp. nov.

?*Phyllachora Guazumae* P. Henn., Hedwigia 48: 7. 1908.

Stromata epiphyllous, numerous, black, shining, irregular or occasionally circular, distinctly convex to subconical, 1–2 mm. in diam., in rare cases 3–4 mm., surrounded by a discolored zone of dead host tissue .5 mm. across; locules many, globose, 200–300 μ in diam.; covered with a well-developed stroma, asci subcylindrical, 63–78 x 13–19 μ; the ascus wall indistinct, spores uniseriate or biseriate in the main body of the ascus, cylindrical, hyaline, continuous, contents uniform when young, becoming distinctly 2-guttulate at maturity; paraphyses present (fig. 20).

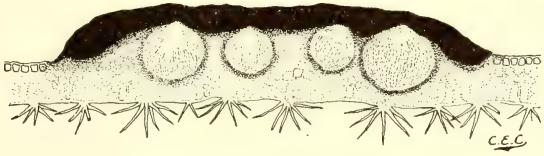

FIG. 3. *Trabutia Guazumae* sp. nov. Cross section of a leaf of *Guazuma ulmifolia* showing plurilocular stroma. The stroma is apparently subcuticular. (Outlined with a camera lucida; × 125).

This form is probably cospecific with *Phyllachora Guazumae* described by Hennings from Brazil. Unfortunately, he worked with immature material and his description is very incomplete, the spores not being mentioned. In the system of Theissen and

Sydow the Porto Rican material falls in the genus *Trabutia* on account of the subcuticular stroma.

MATERIAL EXAMINED:

On *Guazuma ulmifolia* Lam. Cornell University Explorations of Porto Rico (Chardon), No. 895, Penuelas, Aug. 11, 1920 (*type*); id. id. (Chardon), No. 921, Penuelas, July 28, 1920.

Trabutia conica sp. nov.

Stromata epiphyllous, numerous, shining, black, approximately circular, conical and protruding considerably above the surface of the host, 1–2 mm. in diam., subcuticular (?), surrounded by a slightly discolored zone 1 mm. across, the single ostiolum distinct at the apex of the conical stroma; locule single, 300–700 μ in diameter, at first bearing a thick layer of filiform, hyaline conidia, 3–4 x 1 μ, later developing the asci; asci narrowly ellipsoidal, 8-spored, 67–81 x 19–23 μ, the ascus wall indistinct, spores biseriate to inordinate, globose, hyaline, continuous, 10 μ in diam.; paraphyses present (fig. 21).

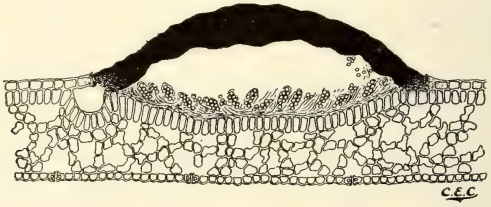

FIG. 4. *Trabutia conica* sp. nov. Cross section of a leaf of *Drepanocarpus lunatus* showing a locule, the subcuticular stroma, asci and ascospores. (Outlined with a camera lucida; × 125).

MATERIAL EXAMINED:

On *Drepanocarpus lunatus* (L. f.) G. Meyer. Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 658, Mayaguez, Mar. 26, 1916 (*type*); id. id. (Whetzel & Olive), No. 634, Martin Pena, Apr. 10, 1916.

Phyllachora canafistulae Stevens & Dalbey, Bot. Gaz. **68**: 55. 1919.

The description of this fungus by Stevens and Dalbey was based

on a single collection made at Mayaguez on *Cassia fistula*. The writer was fortunate in securing abundant material of the species and, moreover, collecting it on a new host, *Cassia grandis*. *Phyllachora Cassiae* P. Henn. reported from Brazil is very distinct from the Porto Rican species in possessing smaller, unilocular stromata and slightly larger spores. The two collections reported by Stevenson (**36**) as *P. Cassiae* are here referred to *P. canafistulae* (fig. 23).

MATERIAL EXAMINED:

On *Cassia fistula* L. Herbarium Insular Experiment Station (Stevenson), No. 3564, Rio Piedras, Dec. 14, 1915; Cornell University Explorations of Porto Rico (Chardon), No. 924, Penuelas, July 30, 1920; id. id. (Chardon), No. 926, Penuelas, July 18, 1920.

On *Cassia grandis* L. Cornell University Explorations of Porto Rico (Chardon), No. 900, Penuelas, July 18, 1920; id. id. (Chardon), No. 916, Penuelas, July 24, 1920.

Phyllachora Serjaniicola sp. nov.

Spots amphigenous, slightly exceeding the stromata, irregular; stromata small, black, shining, 1–4 mm. in diam., visible on both sides of the leaf, occupying the mesophyll, surrounded by a narrow zone of dead host tissue, plurilocular; locules globose to irregular, 180–300 μ in diam.; asci cylindrical, 8-spored, 63–75 x 12–18 μ; spores uniseriate or else biseriate at the apex, ellipsoidal, hyaline, continuous, 10–13 x 6–8 μ; paraphyses present (fig. 18).

The species differs from *Phyllachora duplex* Rehm in having smaller spores and much smaller stromata. A portion of Rehm's type was sent by Doctor L. Romell for examination.

MATERIAL EXAMINED:

On *Serjania polyphylla* Radlk. Cornell University Explorations of Porto Rico (Chardon), No. 923, Penuelas, July 27, 1920 (*type*); id. id. (Chardon), No. 896, Penuelas, Aug. 11, 1920.

Phyllachora Whetzelii sp. nov.

Spots amphigenous, slightly exceeding the stromata, circular in outline; stromata small, purple-black, dull, circular, 1–1.5 mm. in diam., occupying the mesophyll of the leaf; very conspicuous on

the upper surface, slightly less so on the lower; locules globose, 2–4 in each stroma, 150–250 μ across; asci cylindrical, 87–109 x 8–10.5 μ, 8-spored; spores uniseriate, ellipsoidal, hyaline to yellowish green, continuous, 11.5–13 x 3–4 μ; paraphyses very abundant (fig. 24).

This species possesses some of the characters of *Phyllachora biareolata* Speg., but, through the courtesy of Doctor C. Spegazzini, it has been possible to examine a portion of the type material of that species, and our form has been found to be very different in stromatal characters.

MATERIAL EXAMINED:

On *Eugenia* sp. Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 571, Barceloneta, Apr. 6, 1916 (*type*).

SPHAERIALES

SORDARIACEAE

Only one species belonging to this group of dung-inhabiting forms has been reported from the island. The group is probably well represented, but has apparently been neglected by all collectors. The writer has been fortunate in seeing two collections in excellent condition. Both of them have been identified with the aid of Griffiths's monograph (17).

SORDARIA HUMANA (Fuckel) Awd., Abhand. naturf. Gess. Halle 13: 85. 1873.

Spores obovate, 15–19 x 21–23 μ. According to Griffiths, the shape of the spores is the only character which serves to distinguish this species from *S. fimicola,* the spores of the latter being ellipsoidal.

MATERIAL EXAMINED:

On human dung. Cornell University Explorations of Porto Rico (Whetzel & Olive), Maricao, Mar. 16, 1896, deposited in Chardon herbarium as No. 1351.

PLEURAGE ARACHNOIDEA (Niessl.) D. Griff., Mem. Torr. Bot. Club 11: 73. 1901.

Spores 7–9 x 17–19.5 μ, with a very long primary appendage which curves and overlaps the spore below.

Smithsonian Institution
JAN 26 1922
National Museum

MATERIAL EXAMINED:

On cow dung. Porto Rican Fungi (Fink), No. 1241, Mayaguez, Dec. 3, 1915.

SPHAERIACEAE

HERPOTRICHIA ALBIDOSTOMA (Schw.) Sacc., Syll. Fung. 9: 857. 1891.

There have been thus far only four collections of *Herpotrichia* made from the island: two of them collected by Stevenson and two by the writer. Stevenson (37) refers one of his collections to *H. albidostoma* and the other to *H. diffusa*. All four collections have been examined by the writer and it has become evident that they belong to a single species. This conclusion was reached after measuring accurately 100 spores from each specimen and plotting curves which coincide. A wide range in spore lengths, 26 to 40 μ, was observed. The specimens agree with material collected by Langlois in Louisiana and distributed (Ellis & Everh., Fungi Columbiani, No. 1035) under the name of *Herpotrichia diffusa* var. *rhodomphala*. The Porto Rican material, however, is referred here to *H. albidostoma*, the type of which has been examined at the New York Botanical Garden.

MATERIAL EXAMINED:

On shells and debris of *Cocos nucifera* L. Herbarium Insular Experiment Station (Stevenson), No. 2626, Espinosa, Mar. 6, 1915; Cornell University Explorations of Porto Rico (Chardon), No. 1230, Mayaguez, July 14, 1920.

On decaying wood. Herbarium Insular Experiment Station (Stevenson), No. 5586, Rio Piedras, July 4, 1916; Cornell University Explorations of Porto Rico (Chardon), No. 959, Coamo, Aug. 26, 1920.

XYLARIACEAE

HYPOXYLON ANNULATUM (Schw.) Mont., Syll. Crypt.: 213.

This very common species resembles a *Rosellinia*, since the perithecia are sometimes free. Individual perithecia are large, black and bear the papilliform ostiolum at the center of a small disk (fig. 15).

MATERIAL EXAMINED:

On dead wood. Herbarium Insular Experiment Station (Stevenson), No. 2989, Palo Seco, Apr. 24, 1915; Cornell University Explorations of Porto Rico (Whetzel & Olive), No. 764, Maricao, Mar. 13, 1916; id. id. (Chardon), Nos. 953, 963, Coamo, Aug. 23, 1920; id. id. (Chardon), No. 961, Coamo, Aug. 26, 1920.

NUMMULARIA CINCTA Ferd. & Wge., Bot. Tidsk. **29**: 15. 1909.

This form might be confused easily with *N. Bulliardi* in that the stroma is erumpent and pushes the bark to the sides. It differs in that the stroma lacks marked punctulations and is not so characteristically convex (fig. 17).

MATERIAL EXAMINED:

On dead and decaying wood. Herbarium Insular Experiment Station (Stevenson), No. 3464, Rio Piedras, Dec. 12, 1913; id. id. (Johnston & Stevenson), No. 1253, Martin Pena, Jan. 25, 1914; Porto Rican Fungi (Fink), No. 691, Rio Grande, Dec. 7, 1915; Cornell University Explorations of Porto Rico (Chardon), No. 977, Penuelas, July 21, 1920.

The material examined was compared with a fragment of the type kindly supplied by Doctor Ferdinandsen.

NUMMULARIA PUNCTULATA (B. & R.) Sacc., Syll. Fung. **1**: 399. 1882.

This is a very common and characteristic species on account of its smooth and polished stromata. The stroma is broadly effused, 3–10 cm. or more in length and projects but slightly above the bark. Most of the collections are sterile (fig. 16).

MATERIAL EXAMINED:

On dead wood. New York Botanical Garden, Explorations of Porto Rico (Schafer), No. 3687, Sierra de Naguabo, Aug. 10–15, 1914; Herbarium University of Illinois, Porto Rican Fungi (Stevens), No. 112, Dos Bocas, July 8, 1915; Porto Rican Fungi (Fink), No. 974, Mayaguez, Dec. 18, 1915; id. id. (Fink), No. 1785, Aibonito, Jan. 3, 1915; Cornell University Explorations of

Porto Rico (Chardon), No. 976, Penuelas, July 28, 1920; id. id. (Chardon), No. 979, Penuelas, Aug. 7, 1920.

NUMMULARIA REPANDA (Fries) Nitsch. Pyren. Germ: 57. 1867.

Very similar in habit to *N. discreta,* but with ellipsoidal spores, 11–13.5 x 4.5–6.5 μ.

MATERIAL EXAMINED:

On dead wood. Herbarium Insular Experiment Station (Johnston), No. 676, El Yunque, Dec. 12, 1912; Cornell University Explorations of Porto Rico (Chardon), No. 981, Coamo, Aug. 27, 1920.

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EXPLANATION OF PLATES

PLATE 13

Fig. 1. *Lembosia microspora* sp. nov. Group of ascomata; notice there is no evidence of a superficial mycelium. × 11.

Fig. 2. *L. microspora.* Two mature asci; notice the small size of the ascospores when compared with those of the other two species. × 300.

Fig. 3. *L. microspora.* Portion of a leaf of *Ocotea leucoxylon* showing groups of ascomata. × 8/11.

Fig. 4. *Lembosia melastomatum* Mont. Colonies on a fragment of a leaf of *Miconia prasina.* × 8/11.

Fig. 5. *L. melastomatum.* Group of ascomata on the same leaf; notice the profuse development of aerial mycelium. × 11.

Fig. 6. *L. melastomatum.* A mature ascus. × 300.

Fig. 7. *Lembosia tenella* Lév. Group of ascomata on a leaf of *Coccoloba uvifera.* × 11.

Fig. 8. *L. tenella.* An ascus with immature ascospores to the left and two mature ascospores to the right. × 300.

Fig. 9. *L. tenella.* Portion of a leaf of *Coccoloba uvifera* showing characteristic colonies. × 8/11.

PLATE 14

Fig. 10. *Ophionectria portoricensis* sp. nov. A group of perithecia. × 3.

Fig. 11. *Podostroma orbiculare* sp. nov. Two stromata; the one to the left is shown side view and shows the stipitate character. × 3/2.

Fig. 12. *Dothichloe atramentosa* (B. & C.) Atk. Characteristic stromata on leaves of *Chloris petraea.* × 8/11.

Fig. 13. *Dothichloe Aristidae* Atk. Culms of *Aristida portoricensis* with stromata completely encircling them. × 8/11.

Fig. 14. *Dothichloe subnodosa* sp. nov. Stromata on culms of *Ichnanthus pallens;* notice the location of the stromata just beneath the nodes. × 8/11.

Fig. 15. *Hypoxylon annulatum* (Schw.) Mont. Perithecia. × 6.

Fig. 16. *Nummularia punctulata* (B. & R.) Sacc. Stromata on dead wood showing effused character; notice also the smooth polished surface of the stroma. × 8/11.

Fig. 17. *Nummularia cincta* Ferd. & Wge. Stromata on dead wood showing characteristic erumpent habit. × 8/11.

PLATE 15

Fig. 18. *Phyllachora Serjaniicola* sp. nov. Stromata on leaves of *Serjania polyphylla*. × 8/11.

Fig. 19. *Dothidina peribebuyensis* (Speg.) Chardon. Stromata on portion of a leaf of *Miconia* sp. × 8/11.

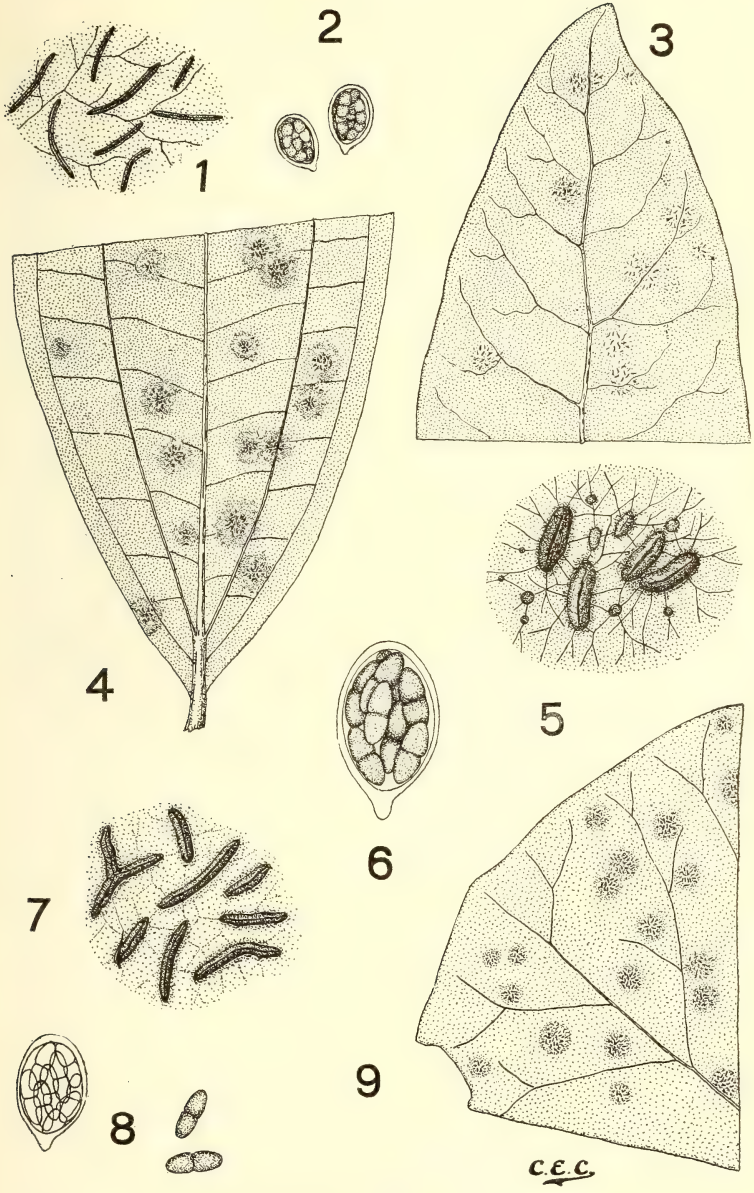
Fig. 20. *Trabutia Guazumae* sp. nov. Fragment of a leaf of *Guazuma ulmifolia* covered with numerous stromata. × 8/11.

Fig. 21. *Trabutia conica* sp. nov. Characteristic stromata on leaves of *Drepanocarpus lunatus*. × 8/11.

Fig. 22. *Trabutia Bucidae* sp. nov. Leaf of *Bucida buceras* with stromata; notice the stromata have a tendency to crowd themselves in colonies. × 8/11.

Fig. 23. *Phyllachora canafistulae* Stevens & Dalby. Stromata on leaves of *Cassia grandis*. × 8/11.

Fig. 24. *Phyllachora Whetzelii* sp. nov. Leaves of *Eugenia* sp. with stromata; notice the circular shape of the stromata. × 8/11.



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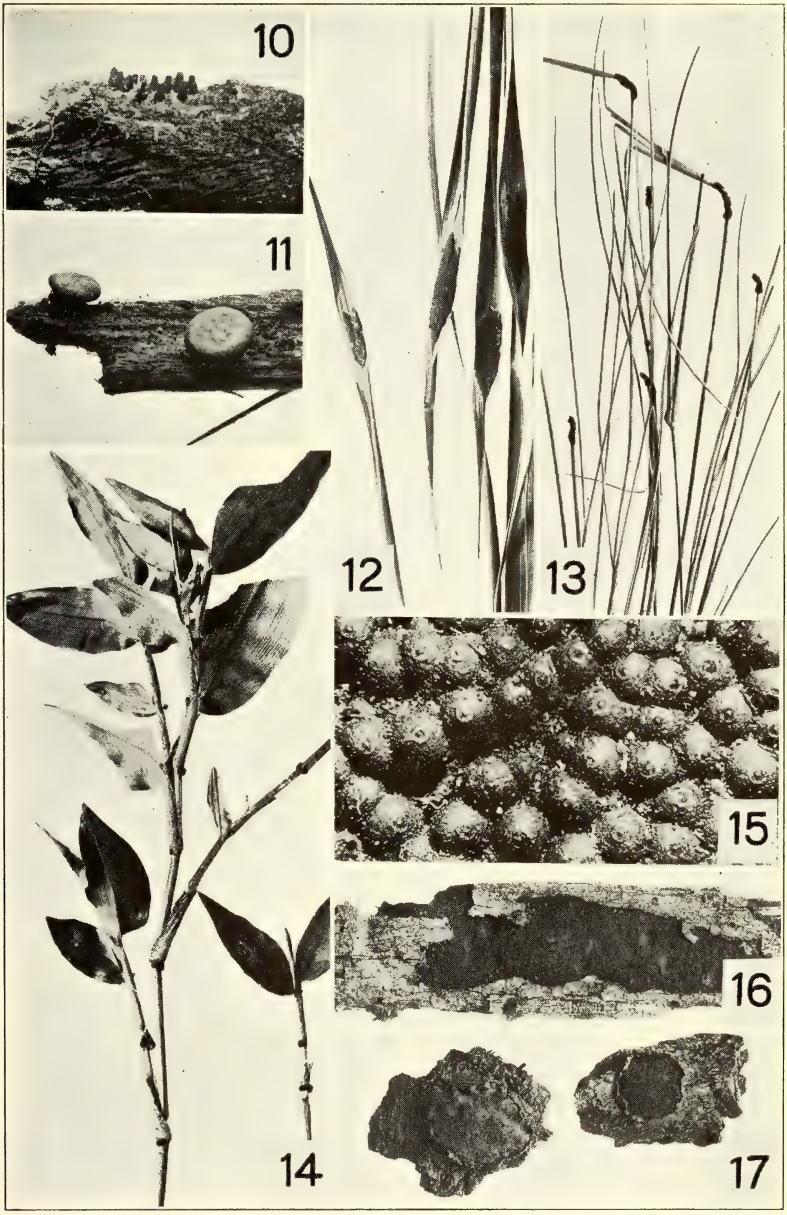
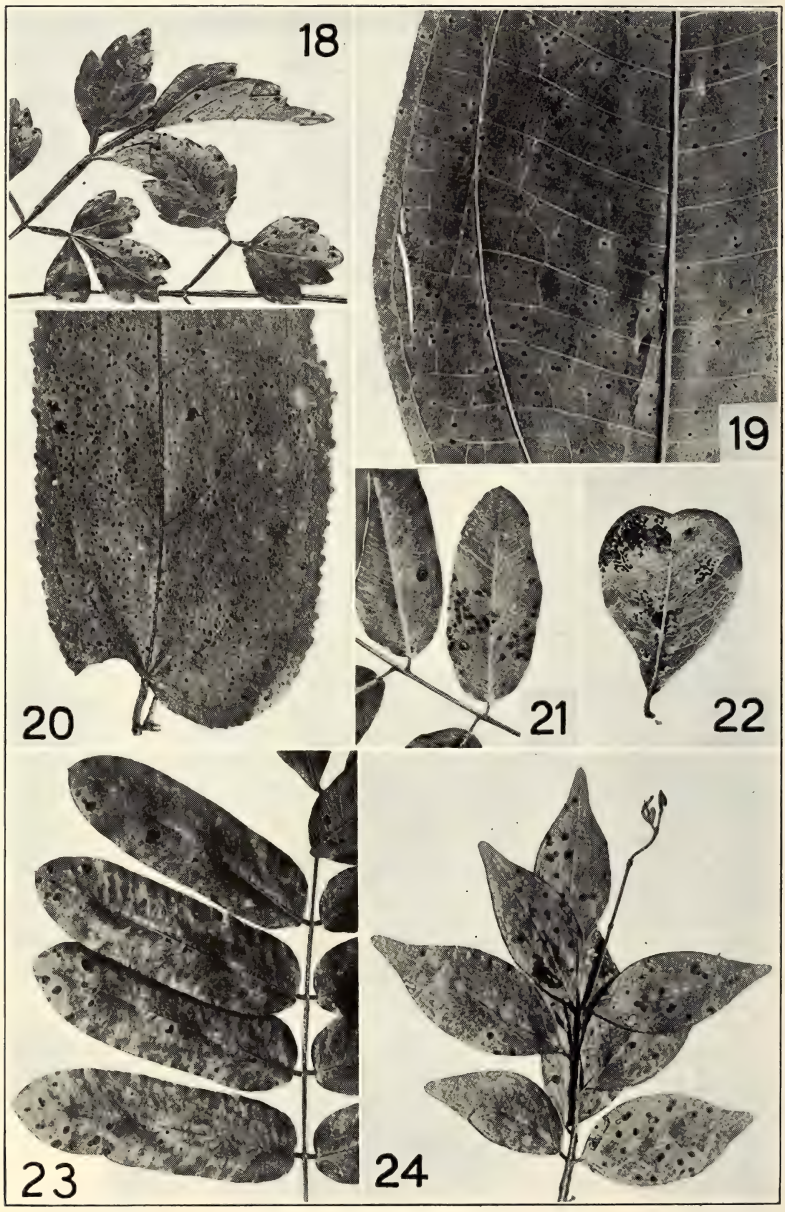


HYPOCREALES AND SPHAERIALES



DOTHIDEALES

CALIFORNIA HYPOGAEOUS FUNGI—TUBERACEAE

Harold E. Parks

The hypogaeous fungi of America form a large, important and little known group. Practically nothing is known of the range of species or their distribution, their edibility or their life histories. Their occurrence in most cases has been noted rather by accident than through any careful or systematic search for them. In California there has been some definite attempt at extensive collection and study of the many different species.

The work was pioneered by Dr. H. W. Harkness. His work was left incomplete, however, at the time of his death and subsequently much of it was lost. It was successful in demonstrating the great variety and extent of the group. The work was then taken up by Dr. W. A. Setchell and Prof. N. L. Gardner, of the University of California, at Berkeley. The only literature available as a guide to the Californian species is the paper of Dr. Harkness, which is, unfortunately, not easily procured. The work is of little value in many ways, as the descriptions have been abbreviated. Dr. Helen M. Gilkey has made a careful "Revision of the Tuberales of California," which is an excellent account of ascomycetous forms. Drs. Zeller and Dodge have also recently published some accounts of the various Hymenogastrales in which are included numerous Californian species.

All of the recent publications will in time have to be revised more or less to include numerous additional species and allow of a modification of the published species. Aside from the paper of Dr. Harkness, there is no literature published which would be of service to the collector in the field. As in the case of the writer, the collectors must go at the work more or less blindly until experience has been gained. With all due allowances for seasonal differences, it is hoped that the following account will be of value to other collectors.

The collection of the hypogaeous fungi of the Santa Cruz Mountains, of California, is based upon a deliberate, carefully planned and systematic search. The writer has now the experience of six seasons' intensive exploration of the mountains adjacent to San Jose. It is a deliberate search that few would persist in season after season over the same ground, yet it becomes a most fascinating game at which to play.

The work begins with the coming of the fall rains and continues all through the winter months and up to the beginning of summer, when the ground becomes too dry for any fungus growths. If the ground is thoroughly covered, it frequently means the crawling into wet thickets on hands and knees and includes all the brambles, briars, poison oak and wood ticks that go along with such experiences. Sometimes the rewards from a mycological standpoint are well worth the effort. The most productive season comes in warm spring months if there has been a fair amount of rain. In some seasons there is little to be found owing to drought. Even if a goodly amount of rain has fallen and a sudden, protracted hot spell follows, the fungi will quickly disappear.

Californian Tuberaceae have been considered in the past to contain no aromatic species. Many of the species are easily detected in the soil by their conspicuous color, but some are rather difficult to find for the same reason. None were supposed to closely resemble the so-called "queen truffles" of Europe. A few resemble closely the white European species. Many are very small and a few attain to some size. Many are of no economic value, while some are large enough and abundant enough to be used for food. Some have a fine nutty flavor, others are apt to be a bit disagreeable. A small black *Tuber* has been found differing widely from any previous species found here and which developed a very strong odor. This last species was found in a spot in which I have collected different specimens every year for the last five seasons. Differing from all other previously collected forms, it turns alcohol to a deep purple color.

The methods of collecting the Tuberales and the Hymenogastrales are the same. The two groups are found frequently grow-

ing intermingled and sometimes are difficult of determination. The latter group forms a most important portion of the hypogaei. They are often large fructifications and are frequently produced in large numbers, and, above all, are strongly aromatic. These aromatic species provide a large amount of food for the rodents, the woodrats (*Neotoma*) being especially active in the search for them and leaving many signs of their work. The study of these signs is of value to the truffle hunter.

Many of the Tuberales appear to be without a conspicuous mycelium, but the Hymenogastrales are usually associated with an abundant white mycelial growth. The exposure of this mycelium will often quickly lead to the desired plants. One or two species of the Hymenogastrales are affected by parasites which leave masses of golden spores under the leaves. The presence of these spores serves as a guide to other species which are frequently associated with the host plants. Excavations made by the rodents for the different species, together with the many fragments left among the leaves, serve as an additional guide. Sometimes on warm, quiet days certain odors may be traced directly to certain species. In the end, however, instinct and experience in selecting favorable locations serve to secure the many different species, and then very often the plants appear in unexpected places where experience shows they should not appear.

Adjacent to San Jose there are ideally wooded hills of mixed oaks both in dense forest and in open scattered groups, and in other places not too far away there are fine forests of conifers and other trees which give the greatest variety of country and timber to work over. This district has been the scene of operations for the last six years. And even when one knows the ground thoroughly it is surprising how little of it may be covered on a day of good collecting. Frequently two or three hours will be spent in working over the ground under a single large oak, and on several occasions an entire afternoon has been spent in one place. The collector may pass rapidly from one place to another, as experience shows the ground to be barren, but though a place is barren one day, it may within a week or so be producing an abundance of fungi.

At Guadaloupe Mines there is a spot where the ground is moist yet warm, beneath a cluster of live oaks, which every season may be depended upon to supply numerous species over a long season. As an illustration of succession of fungi that may be found and the necessity for a constant going over the same ground, my collections for this season will be of value. In November, *Hysterangium* species; January, *Gautieria* species; February, *Genea* species; March, *Tuber* species, and April, *Tuber* species and *Hydnobolites* species. All these were more or less abundant and occurred within an area of less than one hundred square feet. In other seasons this same spot has yielded many other species. In another location where intensive search was made two seasons ago with success the same ground was recently gone over with great care and tubers collected that are probably the most important yet found in the United States. At Saratoga under a single tree that produced a number of species two seasons ago there was collected in February of this year on a single day nine genera and fourteen species.

The equipment of the truffle hunter is important. I use a wheel on many trips, as the roads are excellent and the stops are very frequent in some places. It is easily hidden in the brush when I leave the roadways and take to the high hills, and it makes accessible places otherwise out of one's reach. To the wheel is strapped a small combination rake and hoe with a four-foot handle. This implement is very useful in climbing, raking and digging and furnishes good protection in a snake country, as I well know. A short-handled hoe useful for work in thick brush, a trowel, knife, tweezers, lens, kodak, plenty of newspapers and a large number of small pasteboard cartridge boxes obtained at a shooting gallery. These small boxes are very useful in handling the many small specimens or single individual specimens, while large collections are wrapped in the paper. Lunch and thermos bottle complete the outfit, and all are packed compactly in the large canvas bags used by newsboys. These bags ride comfortably with a large load evenly distributed over the shoulders.

In the earlier parts of the season the edges of the forests and the small groups of trees are usually the best places for operations, although frequently the dense forest will yield good specimens.

Late in the season the best places are to be found deep in the forest, where the ground retains more moisture. When the collector finds a favorable place for operations the rake comes into use and a small area is raked free of leaves and humus. Watch must be kept in the leaves for certain species of *Hymenogaster* and of *Melanogaster* are to be expected and occur frequently. These are dark-colored species and are easily missed. Other species will appear entirely exposed on the surface of the earth and some will be just beneath the surface and out of sight. Excavation may be continued to a depth of a foot, at which depth most species will cease to be found. Care should be taken at all stages, especially near the surface, to avoid injury to specimens, but they will often be injured in spite of it, and many of the dark-colored species will require very careful search and sifting of the soil. The rewards are more often blistered hands and an aching back than truffles, but there are also some intensely exciting moments.

Any account of the underground fungi of the state of California must of necessity be very incomplete, as a large number of the species have not as yet been determined. The large collections already listed are being continually added to with additional species and variations of the older ones. The variations alone are adding many difficulties to the work of final determination. One benefit has accrued in the many collections, and that is the large number of immature specimens which will provide valuable material for life history studies. Where there has heretofore been a very definite lack of such material, it has seemed at times more readily secured than the mature forms.

Genea compacta Hk. originally collected in Marin County, California. Rare. Ascocarps minute, 5–7 mm., reddish brown, globose with oval opening at apex protected by mass of long intermingled dark-colored hairs which arise in clusters and spread fan-like from a series of pyramidal projections arranged at regular intervals around the edge of the apical openings. Minutely and sharply verrucose. Mycelial attachment inconspicuous. Found singly and in large numbers in the vicinity of Alma, spring of 1919. In clay at a depth of over six inches and in light soil among

rocks in thick madrone forest at a depth of two inches. Not easily detected, owing to the color, which resembles the dead dry madrone leaves. Harkness describes the plant as minute, up to one centimeter. Dr. Gilkey describes it as 7–10 cm., which is, I think, an error in printing. Very few tubers reach this size. It is noticeable that the hairs protecting the apical opening to the simple cavity disappear as the plant matures and the opening is enlarged. The same arrangement is seen in another *Genea* recently collected.

Genea arenaria Hk. described from a single collection made by Harkness. Collected subsequently by Prof. Gardner in the vicinity of Berkeley and appearing occasionally among other species in the collections made in the Santa Cruz Mountains. Not abundant, but widely scattered. Habitat favored is the moist clay soil well under large live oaks, plants appearing singly and among other species on the surface of the soil, but well covered with leaves. Ascocarps light brown, very irregularly folded, sharply verrucose; cavities are very complex owing to the folding of the tissue. Plants attain a size of 2–3 cm. in favorable seasons. Very difficult to see in the ground, as the color often blends with the debris on the surface where it appears. Care is necessary in collecting to avoid damage to specimens growing close to the surface of the soil. A faint brown mycelium is evident around the base of the plant, but is very much localized.

Genea Harknessii is widely distributed and very common early in the season. Ascocarps small, black and more or less simple and globose to occasional specimens very complexly folded. Sharply verrucose to the touch, appearing in groups on the surface of the soil well under leaves, under all kinds of shrubs, abundant in old trails and roads overgrown with *Baccharis* sp. Plants are often missed or damaged unless care is taken to avoid the soil surface with the excavating implement. It has been found here on the surface of the ground without leafy covering, on the edge of a hard-beaten road under madrones. Also found in leafy humus under *Arctostaphylos* sp.

This species has a very distinguishing feature in its earlier stages in the presence of a white floccose mycelial covering, enveloping the entire plant, and with hyphal threads penetrating the chambers.

It is not to be seen in old specimens and very quickly disappears after the plants are taken from the ground. Whether this is a parasite is yet to be determined, but the mycelium of the species is scant and dark colored. I find, however, nearly all plants have this covering, while it is not to be seen in other species so far collected.

Genea Gardnerii appears rarely among the specimens of *G. Harknessii,* but usually somewhat later in the season. It is so close in resemblance to the former species that it is difficult to determine offhand. It is black, verrucose and more complexly folded. It appears on the surface of the ground, but well covered with leaves and in places similar to the preceding form.

Genea cerebriformis is collected over wide areas throughout a very long season. It appears in all kinds of soil, but more abundantly in clay soil under oaks. Over one hundred have been collected in the month of January in wet clay soil and in the same ground again in April. Plants are minute, usually under one centimeter, but some of nearly 2.5 cm. have been recently found. The plants are white, rarely simple and globose, but more often a formless mass of complex chambers. Usually found below the surface to a depth of one to three inches, but are rather conspicuous in spite of the very small size. Recent specimens were found to have a very strong odor and to depart radically in size from the description.

Hydnotrya ellipsospora is described from a single collection made in 1909 at Pacific Grove by Prof. N. L. Gardner. It was again reported in March, 1917, when several plants appeared in collections made here. From these the original descriptions were verified. The type of this species is very small, but subsequent collections over four seasons have proven that the type is not representative of the size of the species. It appears in all localities under numerous trees and in various ways. The fresh plants are a very delicate purple color with a delicate "peach bloom" on the surface. This color very rapidly fades and in two or three days is gone, the plants becoming a dull brown. It is frequently found in soft, moist earth at a depth of several inches, but the plants are small. They are often very complexly folded, with very large

empty cavities. The flesh is very much like certain forms of *Peziza*. At Alma under pines there were collected a dozen plants in the month of March in very wet ground. These plants were all partly exposed at the surface of the ground and without any leafy covering. The plants in this collection were all over five centimeters in size and one measured nine centimeters in its largest diameter. At Saratoga the species was found under a great depth of humus and again proved to be of very large size, 7 cm., and still later in the season it was found at Guadaloupe Mines in open rocky ground under oaks. While numerous smaller plants fully matured have been found, these large plants seem to be very common, in so far as this rather rare species may be called common. I think, from my experience, that the plant is widely distributed and abundant in moist years and is rare only for lack of those to collect it. This is large enough and abundant enough to be of value for food purposes, although it is not aromatic.

Tuber californicum is widely distributed and in some seasons very abundant, especially under oaks in moist clay soil. It is to be found on the surface of the soil or just below the surface. Many specimens are to be had by raking over the leaves of solitary oaks or on the edges of oak forests. Frequently the species attains a size of four or five centimeters, which is rather larger than described. It is white and very conspicuous, globose or roughly lobed, frequently irregular in shape and is sometimes deeply cracked in developing. The gleba is at first white, but later appears to be brown. This effect is seen as the spores arrive at maturity, when it appears to be filled with tiny grains of pepper. Its maturity is detected without the aid of a lens. Although this species is edible, it is a trifle astringent to the taste. Aside from this it has no particular flavor. One of the difficulties in collecting this plant for food is the fact that small slugs attack it in its early stages and riddle the gleba, leaving in the end only the peridium as an empty shell. Nematodes and larvae of a tiny black fly also infest the plants once they are opened by the slugs. At Alma I have found dozens of the small immature plants in very wet soil early in the season, but later, when they should have reached maturity, not one plant could be seen. Spore dispersal is secured by means of the slugs.

Tuber candidum is the most commonly collected and widely distributed truffle in this State. It is particularly abundant in some seasons in wet clay soil at the Guadaloupe Mines, generally under the live oaks, but frequently under other trees. It appears late in the winter and continues into the late spring or early summer. April and May seem to produce the greatest amount of mature plants. In places where it is collected in abundance one year it seems to be three or four seasons before it occurs in any large amounts again. The ascocarps are very smooth, pale brown or with a slightly pinkish color, or sometimes, when young, of a dark gray. It is variable as to color and shape. Generally globose or with two or three large lobes, it is sometimes found with deep furrows traversing the surface; occasionally it is cracked to a depth of several millimeters. The peridium is thick, the gleba is at first white, turning to a pale purple color and finally a rich brown, with a tinge of yellow as it reaches maturity, and the yellow spores fill the tissue. The asci may be seen for a long time during the development of the ascocarp, but the spores are slow to mature. In the middle of March I examined a certain piece of ground and found it barren. Two weeks later I collected a pint of mature specimens in it, and repeated two weeks later with some very large specimens. At the next visit, two weeks later, nothing was to be seen but a few empty peridia left by the slugs.

Plants are rarely on the surface of the soil, but are just beneath and down to a depth of several inches, and are easily raked up, but care must be used to avoid damaging them or missing them altogether if they are not abundant. Usually they are rather conspicuous if reddish brown, but if very pale or dull gray they are hard to find. Frequently single plants appear over wide areas, but generally they are in considerable numbers in a small area. They frequently are found in clusters of three or four plants, appearing to arise directly from the spores without any great mycelial growth.

The mycelial growth seems to be very scant and the plants show no basal point of attachment. Many specimens show where loose, fine hyphae traverse the surface of the ascocarp, but these disappear when the plants are removed from the ground. The dis-

persion of the spore is secured by the slugs that infest the plants and also by the rodents that sometimes use them for food. The plants have no odor, but are rather nutty of flavor and are abundant enough to be useful for food. Specimens this year have measured over three centimeters, which is larger than described for the species.

It has been found abundantly in one vineyard near the Guadaloupe Mines, and at Alma I found some fine large plants among the grass roots in a pasture adjacent to live oaks.

Tuber lignarium, or what has passed for that species, as collected in this district is perhaps the most interesting form so far collected. Described originally as *Terfeziopsis lignaria* by Dr. Harkness, the collector, it has been recently placed in the genus *Tuber* by Dr. Gilkey on a very careful study of the original collection. In its general appearance it is very close to *T. candidum.* The plants found here differ somewhat from the description of the type, although they have the typical spores with the recurved spines. During the past season it has proven more abundant than *T. candidum* and is to be found over a wide area and over a long season.

Considering its previous appearance in but one collection its occurrence here is of exceptional interest. In the spring of 1917 a small dark brown tuber, always immature, appeared in collections made all through this district. Plants occurred in all kinds of ground and under many trees, but generally in association with the oaks. Plants are uniformly a dark brown with areas of a lighter color where the venae externae open to the surface. The plants appeared in abundance on the warm upper slopes of the hills, where the growth is more open and the soil moist and light. Plants are found close to the surface, but usually down to a depth of three or four inches.

A long drought occurred and tubers of all kinds were very scarce until the winter of 1918–19. This drought was broken by a prolonged storm early in September of 1918. Over twelve inches of rain fell in three days at the Guadaloupe Mines. Following this rain there came a warm, humid spell lasting over a month, which was ideal for the growth of fungi. On the

27th of September, in an old road well covered with leaves, I collected about a dozen small brown tubers fully matured and growing closely together on the surface of the ground. These were typical specimens of *Tuber lignarium* on the appearance of the spores. The same conditions repeated to some extent in November, 1920, and mature tubers were again collected in the same place. These tubers had fully matured since the rains ceased on the 12th of the month.

In February of the present year the same brown tubers began to appear under the oaks, and in March they were to be found everywhere on the warm upper hillsides, and in April they reached the greatest abundance and maturity. Many of these plants reached a size well over 2 cm. They are very rough in appearance, generally globose or very much lobed, occasionally flattened with the venae externae converging at the apex. The peridium appears to be rough without being verrucose; the tissue of the gleba is at first white, then becoming a faint purple, and finally brown as the mature spores appear all through the tissue. It is very much like *T. candidum* in taste and is without odor. There is very little sign of any mycelium and no point of attachment visible. Plants examined in the ground show only a few fine threads traversing the surface of the plant. Frequent clusters of four plants are found together, apparently arising from spores in the same ascus. In cases like this there is a development of one plant at the expense of the others, it seemingly absorbing its food from the surrounding moist ground, so that one will hardly grow at all, the next but little, the third less than average, while the one may be considerably above the average.

Geopora Harknessii occurs regularly in the winter and early spring in some abundance usually under the pines all through the mountains. I have found it rarely under the oaks. Globose or irregular in shape, roughly folded tissue, with a very dark brown tomentose peridium and reaching a size of 4–5 centimeters if conditions are favorable. The plants are not easily seen under the wet leaves owing to the color. Frequently found on the surface of the ground, but well covered with the pine needles, but very often is to be collected in clay soil fully exposed at the surface.

Hydnotryopsis Setchellii is one of the rarest forms found. It was described from one of the Harkness collections and not reported again until found with other rare forms at Guadaloupe. The plants are small and of a clay color with a white gleba. Found in wet clay soil at a depth of three inches. Material collected here was sufficient to verify all details of the descriptions which were made from long-preserved material. There have been some additional collections and one that would indicate that the species attains a size of over three centimeters.

Delastria rosea has been collected twice, once in an earthy pocket among rock ledges under laurel and once this last season under pines. It is a small inconspicuous plant tinged with red and resembles very much one of the small rosy-colored Hymenogasters. It is, in spite of its color, a very rare and difficult plant to collect. The last collection was made in a bed of purple mycelium which was producing a large amount of a species of *Elaphomyces*. To be expected under all kinds of trees.

Hydnobolites californicus occurs in abundance apparently under all kinds of trees and begins to develop very early in the winter and remains up till the first of June. Very slow in maturing and quickly riddled by the slugs. It appears in a vein of coarse white mycelium, to which it is attached by a long, thick rhizomorph, which breaks away very easily. The point of the attachment is easily seen, however. It is a dirty white, compactly developed globose or irregular ascocarp without a thick protecting peridium as in the various species of *Tuber*. The venae externae open in numerous places to the surface and are very conspicuous in the young plants. It becomes dry and gristly in age, turning to a light brown color.

Several large plants collected late in the season possessed a very strong musty odor without being in any way decayed. These were found in a bed of mycelium about two inches below the surface of the soil under oaks. As the plants matured they pushed farther toward the surface and finally were severed from the mycelium altogether as they reached the surface of the soil, where they were covered very slightly with dry leaves.

Pseudobalsamia magnata occurs early in the season in wet clay

soil under oaks and pines, usually at a depth of one or two inches, in close association with a conspicuous mycelium, and usually with a large number of plants in close relation, although not seen in clusters. Although the plants are, as a rule, less than two centimeters in size, they are conspicuous in color and easily seen. Plants more or less globose or flattened at the apex where the venae externae converge. The peridium is sharply verrucose, somewhat variable in color, gleba white with large asci and spores easily identified. Some plants collected in May and June of this year appear to be this species, but were larger and of a very bright orange color.

A variety of this species, var. *nigra,* has been collected rarely and is little known. What has appeared to be this form appears scattered and solitary on the surface of the ground under laurels. A recent collection of what appeared to be this species, however, gives asci and spores of a very distinct nature and is probably a distinct species, although the general shape is typical of the species.

Pachyphloeus citrinius is not at all well known and the collections are all referred with some doubt. It has appeared twice during the last season in ground that has been searched for the last six years. Just under the surface of the soil under oaks and *Heteromeles* sp. The surface of the plant is covered with minute warts, is of a dark red color, with several folds near the base, a definite mycelial attachment. Plants are globose and with a very deep opening at the center of the apex where the venae externae converge. The tissue of these plants was blood red.

Elaphomyces variegatus is found at various points pretty well buried in the loose soil. It appears in a conspicuous bed of yellow mycelium and is at maturity a large yellow plant very conspicuous in appearance. It is found from January to June following the moisture zones down the hillsides in dense forests. It develops from two to ten inches deep in the soil and reaches a size of 3–4 centimeters, and is globose, roughly warted, with large cells filled with a colorless tissue making up the gleba. The asci dissolve at a very young stage. In maturity the gleba becomes a powdery dark mass of spores resembling a form of *Scleroderma.*

Endogone macrocarpa occurs in many places as isolated plants,

but occasionally a considerable number will be found several inches deep in the soil under an oak. The plants are dirty white or tinged with a faint rosy color at first, globose, 1–2 cm. in size, and when cut open have the appearance of being filled with grains of sand. In one place I have watched for three seasons for a recurrence of hypogaei under an oak where this form was found in considerable abundance in March, but nothing of any kind has been found that would throw light upon the future development of this species.

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THE HETEROECISM OF PUCCINIA MONTANENSIS, P. KOELERIAE, AND P. APOCRYPTA[1]

E. B. Mains

(With Text Figures 1–4)

Puccinia montanensis Ellis, *P. Koeleriae* Arth., and *P. apocrypta* Ellis & Tracy belong to the group of grass rusts having long-covered telia to which *P. triticina* Erikss. and *P. secalina* Grove (*P. dispersa* Erikss.) belong. In connection with the investigation of the last-named rusts, which is being conducted by this laboratory in coöperation with the Office of Cereal Investigations of the U. S. Department of Agriculture, some attention has been given to a study of the related rusts of this group as a part of the general rust investigations of the laboratory, for the help which such a study will afford in the solution of cereal rust problems. In connection with this work considerable taxonomic study of the material in the Arthur herbarium has been necessary, which has resulted in a partial realignment of the rusts involved and has formed the basis for the treatment of these as finally published in the North American Flora.[2]

Puccinia montanensis

Of the three rusts *Puccinia montanensis* is perhaps the most distinctive. It was described by Ellis[3] from a collection upon *Elymus*

[1] Contribution from the Botanical Department of the Purdue University Agricultural Experiment Station. This work is in part a result of the studies being conducted cooperatively between that Department and the Office of Cereal Investigation, Bureau of Plant Industry, U. S. Department of Agriculture.

Read before the Mycological Section of the Botanical Society of America at Chicago, Ill., on Dec. 29, 1920.

[2] Arthur, J. C., & Fromme, F. D. Dicaeoma on Poaceae. North American Flora **7**: 325, 330 and 332. 1920.

[3] Ellis, J. B. Descriptions of Some New Species of Fungi. Journ. Mycol. **1**: 274. 1893.

condensatus made by Rev. F. D. Kelsey at Helena, Montana, July, 1891. An examination of the type (Ellis & Ev., N. Am. Fungi 2892) shows that this rust is to be distinguished from the other grass rusts having long-covered telia by the arrangement of the uredinia and telia in lines, by the broad teliospores and the abundant thin-walled paraphyses bordering the uredinia (fig. 1). In

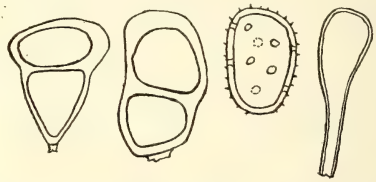

FIG. 1. Teliospores, urediniospore and uredinial paraphysis from the type specimen of *P. montanensis* (x 400).

1915 Arthur[4] sowed aeciospores from *Hydrophyllum capitatum,* obtaining uredinia and telia upon *Agropyron tenerum* and uredinia upon *Elymus virginicus.* This material was determined as *Puccinia montanensis,* and on this basis the Hydrophyllaceous and Boraginaceous aecia of the United States have been considered as belonging to this species.

AECIAL RELATIONSHIP OF PUCCINIA MONTANENSIS

In the spring of 1919 two collections of *Puccinia montanensis,* one upon *Elymus canadensis* and the other upon *Agropyron* sp., made by H. S. Jackson at Boulder, Colo., Nov. 12, 1918, were found to be viable. On the assumption that they should produce aecia upon Boraginaceous or Hydrophyllaceous species, these collections were sown on *Myosotis palustris, Phacelia Purshii, Nyctelea Nyctelea,* and *Hydrophyllum* sp. without obtaining infection. Later in the same summer Mr. E. Bethel sent collections of a rust on *Agropyron tenerum, Agropyron Smithii* and *Hordeum jubatum* which he had collected with Dr. G. H. Coons at Mancos, Colo. Accompanying this material was a collection of aecia on *Berberis Fendleri,* which he stated was so closely associated with the grass rust as to suggest relationship. Such an association did not neces-

[4] Arthur, J. C. Cultures of Uredineae in 1915. Mycologia 8: 137–139. 1915.

sarily mean a connection between the two forms, as the grass rust may have come from aecia upon a plant which had died down and disappeared earlier in the season. Mr. Bethel remarked that the situation was made the more difficult to explain by the absence of *Koeleria cristata,* the grass host supposedly connected with the *Berberis* aecia. On this account, and because of the insistence of Dr. Coons that there must be some connection between the aecia upon *Berberis Fendleri* and the associated grass rust, he sent the material for culture and study. An examination of the material showed that the rust on *Berberis Fendleri* was *Aecidium Fendleri* Tracy & Earle, and that on the grasses was *Puccinia montanensis.* As such a connection would add an entirely new aecial host in a genus rather far removed from *Hydrophyllum,* it became important to establish or disprove this by cultures. The aeciospores, proving viable, were sown and produced infection upon *Hordeum jubatum* and *Hystrix Hystrix.* In the meantime Mr. Bethel made a sowing in his garden at Denver, Colo., from a part of the same collection of aecia and obtained infection upon *Agropyron tenerum.* Mr. Bethel was kind enough to send some of this material to me for study.

Further evidence of this connection was obtained from cultures made in the spring of 1920. Four collections gave infection upon *Berberis Fendleri.* Of these, three were from Mancos, Colo., on *Agropyron tenerum, A. Smithii* and *Agropyron* sp., rusted grasses associated with the *Berberis Fendleri* used in the aecial culture mentioned above. The fourth culture was from telia obtained by Mr. Bethel at Denver by sowing the above aecial material on *Agropyron tenerum.* Ten other collections, eight from Colorado and two from Indiana, were sown on *Berberis Fendleri* without infection. In most of these cases the teliospores germinated weakly, and this may account, in part at least, for the negative results.

A careful comparison was made of the material obtained from the above cultures with the type of *P. montanensis.* It was found that all the material, shown by these cultures to be connected with aecia on *Berberis Fendleri,* agreed closely with the type of *P. montanensis.* The uredinia are cinnamon-brown and are provided

with an abundance of thin-walled, peripheral paraphyses (fig. 2), giving the sori a fringed appearance under the binocular. The

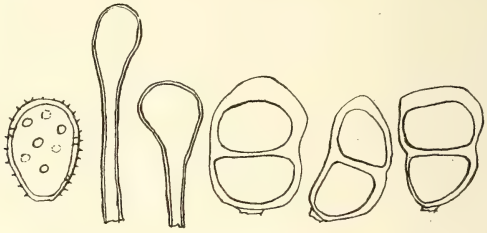

FIG. 2. Urediniospore, uredinial paraphyses and teliospores of *P. montanensis* obtained from culture of *Aecidium Fendleri* on *Hystrix Hystrix* (× 400).

urediniospores are 19–26 by 21–34 μ and have brown walls and 8–10 scattered germ pores. The teliospores are broad, 18–34 by 35–64 μ (fig. 2), and have rather thick walls.

On the other hand, a comparison of the above material with that resulting from the cultures with *Hydrophyllum* aecia mentioned above (Arthur l. c. 4) showed points of marked difference. The uredinia and telia connected with the *Hydrophyllum* aecia are scattered or loosely grouped. The uredinia are yellow and without paraphyses. The urediniospores are 13–21 by 19–25 μ and have pale yellow or colorless walls with 6–8 scattered germ pores. The teliospores are narrow, 13–23 by 32–48 μ, with thin walls except for the apical thickening (fig. 3). On the basis of the above cul-

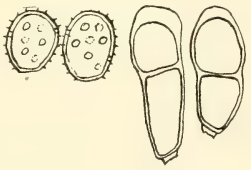

FIG. 3. Urediniospores and teliospores of *P. apocrypta* on *Elymus virginicus* obtained by culture with aeciospores from *Hydrophyllum capitatum* (× 400).

tures, therefore, *Berberis Fendleri* must be considered as the only proven aecial host of this rust. That other aecial hosts exist is a possibility. The geographic distribution of *P. montanensis,* as indicated by specimens in the herbarium, is British Columbia, Wis-

consin, Indiana, southward to New Mexico and southern California, while *Berberis Fendleri* is limited in its distribution to the mountains of Colorado and New Mexico. Such a difference in distribution, however, would be explained if this rust is not dependent upon its aecial stage, but is able to overwinter in the uredinial stage. Mr. Bethel has made observations in Colorado which indicate that such an overwintering may occur there. It is probable, however, that part of the negative results obtained by culturing *P. montanensis* on *Berberis Fendleri* can be explained only by the presence of races in this rust going to different aecial hosts. From present information it is impossible to foretell what these hosts may be. They may be other species of *Berberis* or *Mahonia* or possibly species of some closely allied family. For the present the most that can be said is that *Puccinia montanensis,* in part at least, has *Berberis Fendleri* as its aecial host.

AECIA OF PUCCINIA MONTANENSIS

A study to determine the identity of the aecia on *Berberis Fendleri* obtained from the above-described cultures resulted in finding that they agree with the type of *Aecidium Fendleri* Tracy & Earle. This type also was collected at Mancos, Colo., and Mr. Bethel assures me it was collected at the same place where the material used in the above cultures was obtained. The culture material and the type agree in having aeciospores 18–23 by 20–30 μ. As aecia on *Berberis Fendleri* and the closely related *Mahonia Aquifolium* have been considered as belonging to *Puccinia Koeleriae* Arth., it became necessary to make a study of the latter rust in comparison with *P. montanensis.*

PUCCINIA KOELERIAE

Puccinia Koeleriae Arth.[5] (p. 247) was based on material resulting from cultures in which aecia were produced upon *Mahonia Aquifolium* (Pursh.) Nutt. from teliospores on *Koeleria cristata.* An examination of the type of this species which was collected by E. Bethel at Ouray, Colo., Aug. 23, 1907, shows that it has scat-

[5] Arthur, J. C. Cultures of Uredineae in 1908. Mycologia 1: 225–256. 1909.

tered uredinia and telia, uredinia with thick-walled (1.5–3 μ), peripheral paraphyses (fig. 4), and narrow teliospores, 15–21 by 45–55 μ. In these characters of the uredinia and telia, therefore, *Puccinia Koeleriae* shows a number of important differences from

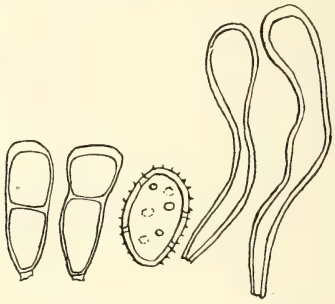

FIG. 4. Teliospores, urediniospore and uredinial paraphyses from the type specimen of *P. Koeleriae* (× 400).

P. montanensis and must be considered as a distinct species, while showing relationship in that both possess abundant paraphyses and urediniospores with brown, thick walls and 8–10 scattered pores.

PUCCINIA APOCRYPTA

A study was made of the rust used by Arthur (l. c. 4) in the cultures of the *Hydrophyllum* aecia mentioned above, in order to establish its identity. As the result of this study it was decided that the rust in question probably was *Puccinia apocrypta* Ellis & Tracy. This rust was described by Ellis & Tracy[6] from material collected by Tracy at Cañon City, Colo., Aug., 1887, on *"Asprella Hystrix,"* which host determination Arthur[7] (p. 138) has shown probably was an error for *Sitanion elymoides*. An examination of this material shows that *Puccinia apocrypta* is very distinct from both *P. montanensis* and *P. Koeleriae,* being distinguished by its smaller, paler urediniospores having fewer germ pores and by the absence of paraphyses in the uredinium. Still further cultural evidence of the aecial relationship of this rust was obtained when, in June,

[6] Ellis, J. B., and Tracy, S. M. A Few New Fungi. Journ. Mycol. **6**: 76–77. 1890.

[7] Arthur, J. C. Cultures of Uredineae in 1915. Mycologia **8**: 125–141. 1916.

1919, Mr. G. R. Hoerner sent a collection of aecia on *Hydrophyllum* obtained at Corvallis, Oregon. Aeciospores from this collection were sown, obtaining infection upon *Elymus virginicus*, with a slight development on *Elymus canadensis* and *Triticum aestivum*, both of the latter, however, proving not to be congenial hosts. A study of the *Elymus virginicus* material showed that it agreed with the other material of *P. apocrypta*.

DISCUSSION

The foregoing work, while by no means settling the complete aecial relationships of these rusts, has resulted in a realignment of them, which, it is felt, is more in keeping with their morphology. *Puccinia montanensis*, so long as it was considered as having its aecia on *Hydrophyllum*, invited comparison with such species as *Puccinia bromina* Erikss. on *Bromus* and *P. secalina* Grove (*P. dispersa*) on rye, both of which have their aecia on the closely allied family, Boraginaceae. From both of these species *P. montanensis* is distinguished, among other characters, by possessing abundant paraphyses in the uredinium, these being practically lacking in both *P. bromina* and *P. secalina*. *Puccinia montanensis* with aecia on *Berberis*, however, invites comparison with other species of rust with long-covered telia having aecia on species of the Berberidaceae. Such species are *Puccinia Koeleriae* in North America with aecia on *Mahonia Aquifolium* and *Puccinia Arrhenatheri* in Europe with aecia on *Berberis vulgaris*. Both the latter rusts agree with *Puccinia montanensis* in possessing abundant paraphyses in the uredinium. In *Puccinia apocrypta*, on the other hand, having *Hydrophyllum* for its aecial host, we have a rust which with its lack of paraphyses, at least, agrees with *P. bromina* and *P. secalina*. It is true that *P. apocrypta* differs from both of the latter in its smaller urediniospores with lighter colored walls, but similar differences can be found in the grass rusts among those having species of Ranunculaceae for their aecial hosts.

It is difficult, of course, to say what other species may serve as aecial hosts for the above rusts besides those shown by culture. It would appear that *Puccinia montanensis* consists of several races, one of which goes to *Berberis Fendleri*. It is not possible at the

present time to say what the aecial hosts of the other race or races may be, but they are likely to be some other species of the Berberidaceae or some closely allied family. *Puccinia apocrypta* presents a somewhat similar situation. As this rust, however, has been cultured only by sowing aeciospores from *Hydrophyllum* on grass hosts, no cultures having been successfully made by sowing teliospores upon a series of Hydrophyllaceous and Boraginaceous species, the aecial host range for this species can not be given with certainty. It is probable, however, that besides *Hydrophyllum capitatum,* which has been shown by culture to be an aecial host, other species of *Hydrophyllum* and species of *Phacelia* and *Nyctelea* will be found to belong here, possibly connected with different races. Whether the Boraginaceous aecia of this country also belong here can only be settled definitely by cultures. It seems probable, however, that a part of these aecia will be found to be connected with rusts identical with or very similar to *Puccinia bromina* and *Puccinia secalina,* and presumably will be found to have their connections with *Bromus* and *Agropyron* rusts. *Puccinia Koeleriae* offers but little information as to its host range, as its aecial connection is founded on only one culture to *Mahonia Aquifolium,* and it is likely that other Berberidaceous species will be found to serve as hosts. A thorough understanding of these species can be reached only through the gradual accumulation of field evidence of associations such as those obtained by Mr. Bethel and Dr. Coons and by cultures to determine both grass and aecial hosts of such rusts. The presence or absence of races and their limitations within the species and the limitations and relations of the species to each other can be determined only by such methods.

To Prof. H. S. Jackson the writer is indebted for helpful suggestions from his knowledge of western rusts. Dr. J. C. Arthur especially has given many helpful suggestions, drawn from his large acquaintanceship and work with this group. The writer also is indebted to Mr. E. Bethel and Dr. G. H. Coons for their discriminating field observations and for material.

DEPARTMENT OF BOTANY,
AGRICULTURAL EXPERIMENT STATION,
LAFAYETTE, INDIANA.

NEW JAPANESE FUNGI

NOTES AND TRANSLATIONS—X

Tyôzaburô Tanaka

Hypodermopsis Theae K. Hara sp. nov. in Chagyôkai (Tea Journal) **14**[7]: 13–14. T. 8, vii, July, 1919. (Japanese.)

Caulicolous, spots orbicular or irregular, large, light reddish-brown; perithecia superficial, scattered or gregarious, flat, orbicular, elliptical or oblong, simply elongated or slightly curved, black or lacquer-black, later lacerate from the middle giving a somewhat hoary appearance, usually veiled with epidermal tissue of the host, 400–700 μ broad, 130–150 μ high, length irregular, wall black, parenchymatous, 40–50 μ thick; asci clavate, oblong-ovoid or short-cylindrical, rounded at the apex, pedicellate at the base, 50–66 x 20–23 μ, paraphysate, octosporous; paraphyses filiform, not forked, equal to or slightly longer than the asci, 1–1.5 μ across; ascospores oblong-ovoid, oblong or pyriform, both ends rounded, multinucleate, 4–6-septate, hyaline, 18–23 x 6–7.5 μ.

Parasitic on the trunks and branches of *Thea sinensis*.

Type localities: Shidzuoka-ken Hamana-gun Hikuma-mura, Nov. 12, 1918 (K. Hara); Shidzuoka-ken Abe-gun Chiyoda-mura, Dec. 6, 1918. (K. Hara.)

Spots occur on the woody part of the tea-plant as light reddish-brown, round or irregular patches at least 5 cm. in diameter. Such spots increase their size in various directions, often running together in large irregular patches entirely surrounding the branches. Black perithecial bodies appear on the diseased spots as scattered or crowded minute dots of 0.5 mm. to 1.0 mm. across. The infected branches die out in a short time.

The Japanese name of the disease: Chaju no Kasshoku Azabyô. (Brown spot of the tea-plant.)

Illustrations: One half-tone plate showing the diseased spot, cross-section of a perithecium, asci (with a paraphysis) and ascospores. (Figs. 1, 5, 6 and 8.)

STAGNOSPORA THEAE K. Hara sp. nov. in Chagyôkai (Tea Journal) 14[7]: 14–15. T. 8, vii, July, 1919. (Japanese.)

Pycnidia scattered, globose or depressed-globose, 100–150 μ in diam., wall parenchymatous, composed of dark brown polygonal cells 4–8 μ in diam.; ostiola even or warty, opening round, 15–20 μ across; pycnospores elongate-cylindrical or sub-clavate, both ends rounded, 6–11-septate, hyaline, 18–35 x 4–5 μ; pedicels of pycnospores short, arising from the base of pycnidial chamber, 4–6 x 2–2.5 μ.

Saprophytic on the trunks of *Thea sinensis.*

Type locality: Shidzuoka-ken Iwara-gun Ejiri-chô, Nov. 24, 1918. (K. Hara.)

Illustrations: One half-tone plate showing diseased spots, section of a pycnidium, pycnospores and pedicels (Figs. 13–16).

LEPTOSPHAERIA HOTTAI K. Hara sp. nov. in Chagyôkai (Tea Journal) 14[9]: 14–15. T. 8, ix, Sept., 1919. (Japanese.)

Leptosphaeria Hottai K. Hara nom. subnud. in Byôchû-gai Zasshi (Journal Plant Prot.) 6[4]: 37. T. 8, iv, April, 1918. (Japanese.)

Spots orbicular or irregular, large, brown, with greasy luster, later darker with minutely crowded dots of perithecia; perithecia superficial, nearly always covered by epidermis, globose or depressed-globose, 350–500 μ in diameter, wall carbonaceous, black, thick, especially so at the place touching the host epidermis so as to show more or less clipeus-form, ostiolate at the apex; opening of ostiola round, 30–45 μ across; asci clavate or cylindric, apex round, base short pedicellate, 60–70 x 8–10 μ, paraphysate, octosporous; paraphyses filiform, considerably longer than the asci, usually simple, hyaline, 1–1.5 μ across; ascospores biseriate or obliquely tri-seriate, ellipsoid, oblong-ovoid or fusoid, at first unicellular and 4-nucleate, later 3-septate with one-sided middle septum, constricted, flavescent, 12–18 x 4.5–5.5 μ.

Parasitic on the trunks of *Thea sinensis.*

Type localities: Ejiri, Hikuma, Mitsuke and Takabe in Shidzuoka Prefecture.

The shape and size of the ascospores resemble *Leptosphaeria Coniothyrium* forma *Theae,* but the shape of the perithecia differ greatly from this species, so a different name is given.

Japanese name: Kuroazabyô (black spot disease).

This disease was at first discovered by Masazô Hotta at Aratama district, Inasa-gun, Shidzuoka-ken, and reported in the Annual Report of Shidzuoka-ken Agricultural Experiment Station (for the fiscal year T. 5, 1916). Hara in the Byôchû-gai Zasshi states that the disease is serious in the vicinity of Hamamatsu and also occurs in the Mie Prefecture.

Illustration: One half-tone text figure showing asci, paraphyses and ascospores. (Fig. 6.)

SILLIA THEAE K. Hara sp. nov. in Chagyôkai (Tea Journal) 14[9]: 15–16. T. 8, ix, Sept., 1919. (Japanese.)

Stromata scattered or gregarious, at first immersed, later erumpent, pillow-shaped or wart-like, sometimes confluent, afterwards with rounded margin adhering to substratum, 0.8–5 mm. in diam., surface orange-yellow or dirty-yellow, rugose with black perithecial spots, inside orange-yellow, somewhat membranaceous in structure, with imbedded perithecia; perithecia globose or ovoid, dark-colored, 300–350 x 180–300 μ, wall carbonaceous or parenchymatous, dark-colored; ostiola terminal, forming wart-like protrusions on the surface of stroma, opening one, round, 80–100 μ across; asci cylindrical or clavate, apex rounded or somewhat mamelon-shaped, base tapering to pedicel, 150–170 x 20–25 μ, paraphysate, octosporous; paraphyses filiform, forked, longer than or equal to the asci, 1–1.5 μ across; ascospores biseriate or irregularly tri-seriate, fusoid, cylindrical or clavate, rounded at both ends, straight, bent or curved, or more or less lunate, with numerous biseriate oil globules, giving the appearance of a septum, 6–11-septate, constricted or straight, hyaline, 35–44 x 8–9 μ, germinating at both ends.

Parasitic on trunks and branches of *Thea sinensis*.

Type locality: Shidzuoka-ken Hamana-gun Hikuma-mura, November 11, 1918. (K. Hara.)

The affected area first appears on one side of branches or trunks as a spot of dark pink or gray color, and by increasing its size it entirely surrounds the bark, simultaneously spreading upwards and downwards. The stroma then makes its appearance as dirty-yellow or in some rare instances pinkish-yellow spots, raised from the diseased surface like warts or a pillow-shaped elevation or sometimes a button-shaped swelling of 0.8–8 mm. in diameter. Perithecial bodies are formed on the stromata as elevated or flat

black spots round in shape. Such spots are solitary or run together to form warts of irregular outline. The dying out of the diseased portion is rather slow, occurring two or three years after the infection. The surrounding area of stromata often develops a greenish color which looks attractive in comparison with pink stromatic bodies.

Suggestions for control: (1) Diseased branches should be removed and destroyed by fire; (2) infected areas on trunks should be peeled off and disinfected with grafting wax or a similar substance; (3) to prevent the disease the woody part of the tree should be washed with Bordeaux mixture.

Japanese name of the disease: Chaju no Samehada-byô (Shark-skin disease of the tea-plant).

Illustration (Fig. 7, on p. 16): One half-tone text figure showing asci, paraphyses and ascospores (one germinating).

ASCOCHYTA THEAE K. Hara sp. nov. in Chagyôkai (Tea Journal) 14^{10}: 13–14. T. 8, x, October, 1919. (Japanese.)

Pycnidia punctiform, globose or depressed-globose, 80–120 μ, wall membranaceous, consisting of dark-brown carbonaceous polygonal cells 5–10 μ in diam.; ostiola apical, even or papillate, opening simple, 10–12 μ across; pycnospores ellipsoid, cylindric or subovoid, both ends rounded or truncate, uniseptate, dividing into homogenous or slightly unequal locules, provided with a large oil globule in each locule, not constricted at the septum, hyaline, 7–10 x 3.5–4.5 μ.

Parasitic on the leaves of *Thea sinensis*.

Type locality: Shidzuoka-ken Abe-gun Okawa-mura, October 24, 1918. (K. Hara.)

Found occurring on tea leaves infected by *Exobasidium reticulatum*.

Illustration: One half-tone text figure showing pycnospores. (Fig. 8, on p. 14.)

VALSA THEAE K. Hara sp. nov. in Chagyôkai (Tea Journal) 14^{11}: 15–16. T. 8, xi, November, 1919. (Japanese.)

Stromata scattered, at first immersed, later erumpent, black, punctiform to the naked eye, conical, apex projecting, black, typically Valsa-like; perithecia annular, 5–10 or more on one stroma,

globose or depressed-globose, 200–350 μ broad, 130–170 μ high, wall fungoid-parenchymatous, black, 12–15 μ in thickness; ostiola separate but grouped, elongate, 30–300 μ long; asci clavate or cylindrical, rounded at the apex, narrowed into pedicel at the base, 25–30 x 4–5 μ; aparaphysate, octosporous; ascospores distichous or irregularly distichous, cylindrical, rounded or truncate at both ends, usually curved in one direction, rarely straight, hyaline or flavescent, 5–10 x 1.5–2 μ.

Parasitic on weakened trunk of *Thea sinensis*.

Type locality: Shidzuoka-ken Hamana-gun Hikuma-mura, December 12, 1918. (K. Hara.)

Illustration: One half-tone text figure showing cross-section of a stroma with perithecia, asci and ascospores. (Fig. 9.)

Notes: There are two species of Valsa found on the tea-plant, but it is still undetermined which causes the die-back of the trunk. The other species not described here has no stroma, though it resembles this species in other respects. The latter is left unnamed until its characters are more fully studied.

DIATRYPE THEAE K. Hara sp. nov. in Chagyôkai (Tea Journal) 14^{11}: 19. T. 8, xi, November, 1919. (Japanese.)

Stromata subepidermal, later erumpent, oblong or linear, 1–2 mm. long, 0.5–1 mm. wide, cross-section oblate-urceolate, slightly rounded at the upper part, flat or somewhat concave at the base, with a broad neck at the top, cinereous, more or less parenchymatous; perithecia deeply immersed in the stroma, globose or ovoid, 300–330 μ high, 100–170 μ in diam., wall parenchymatous, dark colored, 15–30 μ thick, long ostiolate; ostiola penetrating the stromatic neck, opening round, 20–25 μ across; asci clavate or obovoid, apex usually narrowed, rarely swollen and rounded, base tapering very much into a filiform pedicel, 20–40 x 6–8 μ, aparaphysate, octosporous; ascospores cylindrical or fusoid, rounded at both ends, straight or curved, plane or nucleate at both ends, hyaline or flavescent, 7–11 x 2–2.5 μ.

Saprophytic on the trunks of *Thea sinensis*.

Type locality: Shidzuoka-ken Abe-gun Ôkawa-mura, October 24, 1918. (K. Hara.)

Differs from *Diatrype stigma* (Hoffm.) Fr. in the shape of the stromata, also from *D. Hochelagae* E. & E. in the aparaphysate asci. The former is found in the same village where the present species was discovered.

Illustration: One half-tone text figure showing infected trunk, cross-section of a stroma, asci and ascospores (Fig. 12).

HENDERSONIA THEAE K. Hara sp. nov. Chagyôkai (Tea Journal) 14^{12}: 22–23. T. 8, December, 1919. (Japanese.)

Pycnidia globose or depressed-globose, 60–130 μ in diam., immersed, later slightly erumpent, pycnidial wall parenchymatous, composed of angular cells of 4–7 μ in diam., apically ostiolate; ostiola papillate or warty, with opening 11–15 μ across; pycnospores broad-ellipsoid or broad-fusoid, broadest near the middle, narrowed toward both ends, at first hyaline, finally changing to yellowish-brown, 3-septate, somewhat constricted, 7–10 x 4–5 μ.

Parasitic on the leaves of *Thea sinensis*.

Type locality: Shidzuoka-ken Abe-gun Okawa-mura, October 24, 1918. (K. Hara.)

Foliicolous, appearing mostly at the leaf tips, on spots that increase their area downward by degrees toward the leaf base with definite but undulating border lines. The infected area is at first dark brown, but later it changes color, becoming gray, and minute spottings of fungus bodies appear somewhat sparsely on the surface. The lower surface of the diseased area is light brown in color.

Illustration: One half-tone text figure showing an infected leaf, a section of a pycnidium and pycnospores. (Fig. 13, nos. 1, 2, 3.)

Since March, 1919, Kanesuke Hara has been publishing in Chagyôkai (Tea Journal) a series of papers dealing with the diseases of the tea-plant, in which he describes a number of new species of fungi. The translations given here and in the last number of New Japanese Fungi (Mycologia 12^{6}: 330–332) cover nearly all of those published in 1919; the rest of his new species will be given in the subsequent numbers of this series.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

SOME OF THE WAYS OF THE SLIME-MOULD

THOMAS H. MACBRIDE

A recent volume by Professor D'Arcy W. Thompson, bearing the terse title "Growth and Form," seems to me for the mycologist very suggestive, and to that extent, at least, one of the most useful among the books of later years. A paragraph from its pages might form the text for the discussions of the present paper. After developing at length and very clearly the various problems of tension, particularly as determined by molecular attractions, in liquids mass-tensions, surface-tension and their interactions, the author applies to *Æthalium,* a common slime-mould, the same principles applicable to so much water, assuming the myxomycete to have the same specific gravity, and both liquids placed for experiment under similar conditions. The paragraph, too long for quoting here, is noteworthy for two reasons: in the first place it presents, as is believed, the first citation of a slime-mould anywhere or at any time in a court of physical research; and in the second place, it is the first attempt, so far as I have noted, to refer the phenomena especially characteristic of the organisms in question to forces purely physical in nature—*i.e.,* to such as are familiar to the laboratories of purely physical science.

In these days of refined and beautiful physical research chemical and physical reactions are so interrelated that only the most accomplished expert in either or both fields may venture their mention, not to say discussion. The present writer makes no pretension; but there are in the life history of the slime-moulds certain peculiar facts, patent to ordinary observation, always worthy of study and, as it would seem, deserving, for thorough apprehension, not to say comprehension, all the help that physical science may afford. Professor Thompson's argument is very helpful, and yet—as illustrating the way of the slime-mould—permit me to summon the chief offender.

In 1876 Sachs in the one-time classic Physiology, discussing

protoplasm, refers to *Æthalium* and goes on to say: "It may happen that the substance creeps up the stems of plants a metre high and moves in the form of thin threads becoming collected above on large leaves as thick cakes the size of the hand. . . . There remains no doubt whatever that we have here to do with a structure which resembles in every detail the circulating protoplasm in living plant cells, only its mass is relatively extraordinarily large."

What we have to account for is the continuous stream that carries on until apparently the source of supply is exhausted, and accumulates at considerable elevation masses to be weighed in ounces, say, half a pound. It matters not that ascent was made a meter high; a centimeter high would do just as well, as far as that goes. I have photographed the same thing, eight feet above its base of operations, seated in the crotch of a vigorous bur-oak tree.

It is an old story. Men have been watching the phenomenon for two hundred years. Linné saw the mucors, as he called them, but was less a student. The greater man by far, the greatest mycologist the world has known, devotes pages to our problem. Fries says in Systema Mycologicum: "Often have my eyes, not without peculiar pleasure, watched the transition from weak beginnings to the perfection of complete development. The celerity in most of them is marvellous. At one time (for safe carriage) I deposited the plasmodium of a *Diachæa* in my hat, and within the space of one hour it had covered the greater part of it with its elegant white net work."

It must not be supposed that the outer head of the great Swedish student, no matter how brilliant the brain it covered, left the inner surface of the hat any less free from what, for cytoplasm, printers might term "objectionable matter," than would be the case did the hat cover the best brushed and tended human capital to be found in Chicago, and yet I have no doubt whatever of the accuracy of the Friesian narrative.

Permit me to cite a more recent observation: On the shore of an Iowa lake, not far from the water edge, I found one morning in July, 1909, a plasmodium emerging from beneath a boulder and

beginning the ascent of the overhanging face. Over the boulder I turned a tight, wooden box. In course of a few hours I found on the summit of the boulder, eight or ten inches high, as fine an *Æthalium* as anyone could wish to see. At the same time the vertical box wall showed plenty of belated, ascending streams, no doubt intended for a second *Æthalium* somewhere within the overturned box.

I have cited this last example because it seems to me to afford the simplest illustration we are likely to have, at least in the field, of the problem with which biophysics has to deal. The plasmodium, *i.e.,* the *Æthalium* of the physicist, in every case, we may assume, the same,—a mass of naked protoplasm, made up of myriads of minute, almost undifferentiated living cells, so associated as to be undistinguishable, at least in life,—is to the physicist a fluid, homogeneous, only slightly more dense than water, if at all; subject to desiccation, but not at all aquatic, requiring for translative movement, not a wet surface, not at all,—such perhaps in a measure prohibitive,—but probably best an invisible film, such as the moist atmosphere of summer might lend to any slightly cooler surface; too dry, doubtless as a matter of course, unfavorable. Of course, there can be no movement here as elsewhere, unless there is resistance, some point d'appui; so having considered the athlete, let us now consider the Matterhorn of his ambition.

Of the three instances of accomplishment, the second, the Friesian episode, may be now neglected as offering no special matters of distinction; if we are to overcome gravitation at all, the living stem of the growing plant would seem to afford highway most practicable, covered, we may suppose, with inequalities, points, projections of every sort as it surely is. This seems really of small advantage, if not a hindrance, to be surmounted; the glaucous glabrous shaft of *Impatiens* found in practice, useful for ascent as any other.

Let us study, then, the lake-side case. Here the journey was made around the blunt edge of an overhanging shelf; the action of gravity not only contrary to the general course of progress, but also in part (vertically) athwart it, as if to pull the climber from its hold. Nevertheless, as stated, and in abundant measure, the

journey was accomplished, no doubt on schedule time. Just why this journey was made it is hard to say, in view of the patent fact that for the plasmodium many another was quite open; much easier of accomplishment one would say, since other courses lay on the level, or even, gravity now favoring, downward amid recesses of rotting leaves and wood, whence the fountain welled. *Æthalium* is surely not geotropic, nor hydrotropic, since it now moved from these directions; neither was it heliotropic, nor even phototropic, in its turning; the gloom of the overshadowing box affected not the culmination of some overmastering push with which the movement started. Thermotropism there may have been, but the heat difference between the upper exposed portion of the boulder and that buried slightly in the forest mould could hardly have been great. In any case, light and warmth had been for days quite as tempting as in the hour the movement started; the impulse must have some other probably internal physiologic origin; doubtless some change molecular, since the outcome is maturity and fruit.

The biologist might go on to say that since the myxo is reproduced by spores distributed by air currents, or perchance the wind, only such fruits as rise above the general, local level have superior chances in the game of life; success is with those that climb; how the climbing is accomplished the biologist does not say.

But here the physicist may help us much. He steps in to say that every fluid drop or mass meets its environment by a skin, a film in tension, surface-tension, and this in case of your plasmodic stream holds fast sufficient to prevent gravity from pulling your hardy climbers from the Matterhorn, even from the overhanging shelf; while some internal, molecular changes in the cytoplasm itself, doubtless of physiologic import as the biologist suggests, sends the climber up and on to the fulfilment of physiologic function.

But *Æthalium* furnishes a special case. Not every myxo is by any means so rich either in material or equipment, but all aspire; generally speaking, all, even the most minute, show strange ambition, strive to reach upward or outward, if but a little way toward the open air. The behavior of *Æthalium* (most students say *Fuligo*) is strange enough, but the fruiting performance of some

of the more delicate species is more wonderful, more marvelous still.

The keen-eyed Swede, in what he could see with the lenses of a hundred years ago, never ceased his expressions of wonder; they are on every page. According to his theory, vegetation is always a matter of expansion, fruiting of contraction. And so when the plasmodium of some *Trichia, Craterium* or *Arcyria,* oozing up from its hidden nutritive base, began to spread before him in hundreds of thread-like streams covering the whole upper surface of some forest-shaded log or some bed of smouldering leaves, he was charmed; sat watching hour by hour, until over the whole field the threads began to break; rallying points not distant far from one another appearing along each filmy line, he was delighted; contraction succeeded expansion and he was satisfied. But when he returned perhaps on the following day to find that from every point a tiny stem had arisen, each surmounted by a glistening spherule large enough, unless perfectly erect, to bear the little stem to earth, his admiration knew no bounds; he said, "I find nothing more wonderful in all the world of plants."

We of today, seeing so much better and knowing so much more exactly the substance with which we have to deal, may, if we stop to reflect, be no less surprised than was our old-time master. We, far better than did he, know the nature of that thready stream, and may be moved perhaps to greater wonder when it ascends and stiffens several millimeters above the general level, and ends by bearing a sphere upon the expanded summit.

I am free to confess that I watched the procedure long before I learned its methods.

Any such mass of naked protoplasm as that we now discuss shows to ordinary observation a differentiated ectosarc, in appearance not very different from that which it incloses, but still distinct. This ectosarc, then, above occupies no doubt the field of surface-tension. As the physicist has taught us surface- and mass-tension are and remain in relative equilibrium as obedient to some internal force, the currents of the plasmodium push their varied way. But once in the physiologic history of the organism, the tension equilibrium is at any point disturbed in favor of the mass,

the ectosarc at that point yields; the inner cytoplasm follows, usually in direction normal to the basic surface, aided, of course, now by relatively increased surface-tension pressure on each side. As the ectosarc is thus carried up, it becomes, by desiccation perhaps, steadily fixed, from below upward, in position as in form, becomes indeed a capillary tubule closed entirely above by a film of ever-diminishing thickness. Against this continues the mass-pressure of the inner cytoplasm, spore-plasm it shall be, squeezed by increasing surface-tension from below, helped now no doubt by the capillarity of the hollow stem, until the upper remaining membrane, stretched to extreme tenuity by uniform pressure, becomes spherical in shape, and receives, so far as possible, all the cytoplasm from below, ready for conversion into spores.

That we have hit upon the correct solution of our problem is, in this case, further evidenced by the circumstance that sometimes the surface-tension at the base begins to lessen before all the spore-plasm has reached the summit and, equilibrium attained, part of the more vital endosarc remains below, lodged in the hollow stem. Here, with such success as may be, spore formation takes place as in the camera above, and the discerning taxonomist then writes, "stipe stuffed with spores, cells, capillitial threads, etc."

Such are some of the ways of the slime-mould, some of the devices by which it uses earth's various forces and conditions. The botanist tells us what he can see, viz., what his favorites *can* do, and possibly *why* they do it; the man of hydrostatics tells us how, once started, they effect their wonders; but of the molecular energy which still, over and over again, sends flood to fructification, and fruiting back again to flood, by constant, predetermined ways and paths, we still say little; that remains no doubt the general resultant of all those multifarious actions, reactions, attractions and repellings, which everywhere condition the manifestation of what we know and feel as life, and know and say no more.

STATE UNIVERSITY OF IOWA,
IOWA CITY, IOWA

NOTES AND BRIEF ARTICLES

[*Unsigned notes are by the editor*]

Professor Arthur H. Graves, formerly of Yale University, has been called to the Brooklyn Botanic Garden to take charge of the Department of Public Instruction and to devote as much time as possible to mycological work.

Mr. E. J. Butler, Director of the Imperial Bureau of Mycology, Kew, England, who has made a tour of parts of the United States in the interest of pure mycology, visited the Garden on August 18 and sailed shortly afterward for England.

Dr. K. Miyabe, Professor of Botany in the Imperial University at Sapporo, Japan, called at the Garden August 20 and 22 on his return from the Conference of Cereal Diseases held at St. Paul, Minnesota. He sailed from San Francisco September 17, having been in the United States since the first of July.

Dr. E. A. Burt, of the Missouri Botanical Garden, visited the Garden on August 16 to examine certain species of *Clavaria* in the mycological herbarium. He had examined material of this genus at Albany, Cambridge, and elsewhere, and returned to St. Louis by way of New York and Philadelphia.

Mr. A. A. Pearson, Treasurer of the British Mycological Society, visited the Garden early in October before he sailed home to England. He was much interested in our native fungous flora and made several excursions into the woods to collect and study the more conspicuous forms of fleshy and woody fungi.

Dr. G. R. Bisby has applied for leave of absence from the Manitoba Agricultural College at Winnipeg, beginning October, 1921, to accept a position with the British Imperial Bureau of Mycology,

of which Dr. E. J. Butler is Director, with headquarters at Kew Gardens, London. The address is 17 Kew Green, Kew, Surrey, England.

A disease of English ivy caused by *Bacterium Hederae* has been studied and described at Paris by Arnaud (Compt. Rend. for 1920). The symptoms are said to resemble those produced on beans in America by *Pseudomonas Phaseoli.*

Isoachlya, a new genus of the Saprolegniaceae, was described by Kauffman in the *American Journal of Botany* for May, 1921. Three species are included, *I. toruloides* Kauffm. & Coker being new and the other two transferred from *Achlya* and *Saprolegnia.*

Professor Buller has recently sent me a reprint of his article, entitled "Die Erzeugung und Befreiung der Sporen bei *Coprinus sterquilinus,*" which was published in the Jahrb. f. Wissensch. Bot. in 1915. It contains 30 pages of text and 2 handsome double plates.

Mr. Weir finds that not only *Thelephora terrestris,* but also *T. fimbriata* and *T. caryophyllea,* are injurious to coniferous seedlings in the Northwest, owing to their habit of growing up about them and strangling them. See *Phytopathology* for March, 1921.

Miss Bessie Etter has published in *Phytopathology* for March, 1921, an article describing the equipment necessary for making successful field cultures of various wood-rotting fungi. Corn-meal agar and malt agar gave the best results for initial inoculations.

Miss Wakefield, the mycologist at Kew, has recently published a paper of 20 pages on the "Fungi of New Caledonia and the Loyalty Islands." She was assisted by Mr. Massee on certain groups and Mr. Cotton named the Clavarias. Eight new species are described.

Plans for the summer field meeting of cereal pathologists, July 19–22, at University Farm, St. Paul, Minnesota, included excursions to grain fields, elevators and mills in the vicinity of Minneapolis and Fargo. A number of foreign plant pathologists were in attendance.

Professor Massey, of Cornell University, has found by an experiment covering a period of three years that crown canker, *Cylindrocladium scoparium* Morg., causes a loss in the case of Ophelia roses grown under glass of about ten blossoms, or one dollar, per plant. See *Phytopathology* for March, 1921.

Barlot has experimented with various chemicals for color reactions to distinguish poisonous and non-poisonous species of *Amanita* (Compt. Rend. **170**: 679–681. 1920). For example, he found that three deadly species turned black when treated with drops of fresh blood to which potassium ferrocyanide had been added.

A paper by Saccardo, entitled "Mycetes Boreali-Americani," which appeared in the *Nuovo Giornale Botanico Italiano* for 1920, includes notes on 98 species of fungi sent by Weir from the Northwest for determination. Thirty of these species were described as new, most of them in the groups with which Saccardo was familiar.

Investigations of *Cronartium ribicola* in 1920 by Pennington and others brought out two very important points: that species of *Ribes* are often killed by intensive outbreaks of the fungus in a definite area, and that the aeciospores may be blown an indefinite number of miles and cause new infections on *Ribes*. See *Phytopathology* for April, 1921.

A glume blotch of wheat, caused by *Septoria nodorum* Berk., has been under observation for three seasons about Fayetteville, Arkansas, and Mr. H. R. Rosen has now published an account of it in Bulletin 175 of the Arkansas Agricultural Experiment Station. He considers it next in importance to leaf rust as a disease of wheat in Arkansas.

Povah has studied poplar canker, caused by *Cytospora chrysosperma,* in an area near Syracuse, New York, where the trees were weakened by fire, and he finds that in this area 68 per cent. of the poplars were infected and over 30 per cent. killed. Three species of poplars were observed and subjected to inoculation experiments. See *Phytopathology* for April, 1921.

A long illustrated paper on "Cultural Studies of Species of *Actinomyces,*" by S. A. Waksman, appeared in *Soil Science* for August, 1919. This is a notable contribution to our knowledge of soil organisms, the importance of which is being more and more recognized. The paper contains a key to the species of *Actinomyces* based chiefly on biochemical characters.

Mr. Paul C. Standley has called my attention to an article by Hans Schinz, entitled "Der Pilzmarkt der Stadt Zürich der Jahre 1918 und 1919 im Lichte der städtischen Kontrolle," published in Vierteljahr. Naturf. Gesell. Zürich, vol. 56, p. 530. The control of mushroom markets must come in this country as soon as wild mushrooms are offered for sale in any quantity.

A dangerous tobacco disease has appeared in the southern United States, according to Smith and McKenney, apparently due to *Peronospora Hyoscyami,* which was originally described by DeBary from the black nightshade of Europe. This downy mildew attacks the tobacco seedlings in the plant beds, causing great havoc. In Florida, Bordeaux has proven more effective than in Australia, but spraying experiments are still incomplete.

Entoloma albidum Murrill, a species originally described from Stockbridge, Massachusetts, is reported by Dr. H. D. House as the cause of violent illness when eaten by a family of five in Albany late in August, 1921. Specimens were submitted to me for identification. *Entoloma lividum,* of Europe, is dangerously poisonous, and American species of this genus are naturally under suspicion, but few of them have been tested.

"The Fungi of Our Common Nuts and Pits" is the title of an interesting and important paper recently contributed by Dr. C. E. Fairman to the *Proceedings of the Rochester Academy of Science*. Both saprophytic and parasitic fungi are included among the hundred or more species listed. About thirty species and one genus are described as new. The six plates are unfortunately rather poor, but doubtless serve their purpose.

Silver-leaf disease, caused by *Stereum purpureum*, occurs on a variety of trees and shrubs in England, the hyphae of the fungus being always present in the stem and roots of plants that are attacked, but never in the leaves. Infection takes place through wounds. There is a false silver-leaf disease, apparently not due to fungous attack, which must be carefully distinguished. See Bintner in *Kew Bull. Misc.* for 1919.

I am sending under separate cover some specimens of *Calostoma Ravenelii* which I collected on my farm near Conway, Kentucky. The plants were growing in a clay bank along a wooded roadside where the soil had been disturbed within a year or two. The farm lies between the blue grass and the foothills. I had never seen a *Calostoma* before and was wonderfully interested in the find. The collection was made September 6, 1921.—*Bruce Fink.*

A fine specimen of what appears to be the rare *Stereum petalodes* Berk. has recently come in from Las Ninfas, Cuba, collected there by Brother Hioram in midwinter. Professor Burt, to whom a part of the specimen was sent, writes me: "I presume it must be this species, as you determined. I have not seen the authentic specimen of this species at Kew, but should I ever cross the water again I have noted this specimen for comparison with the original."

The correspondence of Schweinitz and Torrey, the two dominating figures in American botany during the early part of the nineteenth century, has been collected and published by C. L. Shear and N. E. Stevens as a memoir of the Torrey Botanical Club, dated July 16, 1921. There is also included a list of the

publications cited, prepared by Florence P. Smith, and biographical notices of persons mentioned in the correspondence, contributed by J. H. Barnhart.

A new leaf-spot of the so-called Egyptian lotus caused by *Alternaria Nelumbii* is described and figured by Enlows and Rand in *Phytopathology* for March, 1921. It appears as very small, smooth, reddish-brown flecks, which increase to a diameter of 5–10 mm. No perfect stage was discovered, but the conidial stage appears to possess great longevity. This disease was first observed by Rand in 1913 at Kenilworth, D. C., and at the New York Botanical Garden.

In Department Circular 177 of the U. S. Department of Agriculture, prepared by Martin and others, a method of treatment is outlined for ornamental pines affected by blister-rust. It is claimed that "infected ornamental pines can be saved by properly cutting out the diseased parts, if the work is done in time. The best results will be obtained in the spring, and success depends upon finding and completely removing the cankers. Tree surgery of this kind can be performed by the owner at small cost."

Farmers' Bulletin 1187 of the U. S. Department of Agriculture, by W. W. Gilbert, deals in a popular way with the chief diseases of cotton and their control. Wilt, caused by *Fusarium vasinfectum,* is controlled by the use of resistant varieties and crop rotation. Anthracnose, due to *Gloeosporium Gossypii,* also requires rotation and resistant varieties, care being taken to use only perfectly healthy seed. Bacterial blight requires the same treatment as anthracnose. Other minor fungous diseases are also described in this bulletin.

A new budrot disease of Cannas due to *Bacterium Cannae* is described and figured by Mary K. Bryan in the *Journal of Agricultural Research* for May 2, 1921. Infection takes place through the stomata and spreads through the intercellular spaces of the parenchyma of leaf-blade, petiole and stalk. The disease is most

destructive early in the season, that is, on young plants. It begins in the hothouse and continues in the open beds. It destroys the buds, forms large unsightly spots on the leaves and ruins the blossom clusters by blighting the flower buds or by decaying the stalk. No means of control has yet been worked out.

I received from Dr. Overholts last August a fresh specimen of *Poria semitincta* which was colored a beautiful, delicate lilac (*lilacinus*) on the margin for a centimeter or more, while the hymenium was entirely white or with dirty pale-yellowish-white stains. The following note accompanied the specimens:

"I am sending you under separate cover a fresh specimen of *Poria semitincta* Peck. I do not know how familiar you may be with the fresh coloration in good specimens of this species, and it is worth seeing. The color gradually fades in herbarium specimens, and a collection of October, 1919, with colors as in this specimen has now almost faded out. This is my fourth collection, and I have had it twice from correspondents."

An excellent professional paper of one hundred pages on "Damping-off in Forest Nurseries," by Carl Hartley, appeared last June as Bulletin 934 of the U. S. Department of Agriculture. Damping-off in nurseries is caused mainly by seedling parasites which are not specialized as to host; *Pythium Debaryanum* and *Corticium vagum* are probably the most important of these. The most serious losses in conifers are ordinarily from the root-rot type of damping-off, occurring soon after the seedlings appear above ground and while the hypocotyls are still soft. The best control method appears to be the disinfectant treatment of the seedbed soil before or immediately after the seed is sown. Sulphuric acid has been found very useful for conifers, as they are apparently especially tolerant of acid treatment. Broad-leaved tree seedlings rarely suffer seriously from the attacks of damping-off fungi.

The British Mycological Society is interested in a collection of type cultures to be assembled and maintained at the Lister Institute, Chelsea Gardens, London. It is proposed to collect and

maintain cultures of fungi of importance in phytopathology, medicine, veterinary science, technology and soil biology, types useful for teaching purposes and any rare or interesting species. The coöperation of bacteriologists and mycologists is earnestly invited, and in return every effort will be made to supply the needs of applicants for cultures. In the case of fungi it is necessary at present to restrict the collection to fully identified species. Cultures will be supplied on demand, so far as possible, to workers at home and abroad, and, as a rule, a small charge will be made to defray the cost of media and postage. Annual lists of the fungi in the collection will be published in the Transactions of the British Mycological Society.

The *Journal of Agricultural Research* for April 15, 1921, contains an important illustrated article by Annie May Hurd on seed-coat injury and viability of seeds of wheat and barley as factors in susceptibility to molds and fungicides. An unbroken seed coat ordinarily affords absolute protection against attack of living seeds by *Penicillium* or *Rhizopus,* while the location of a break in the seed coat determines the ability of these and other saprophytic fungi to invade seeds, either in the soil or in storage. If the injury is over the endosperm, 100 per cent. fatal infection results when the spores of *Penicillium* or *Rhizopus* are present; but if it is over the embryo, the seeds remain practically immune. The vitality of seeds is also a factor in determining the ability of *Penicillium* and *Rhizopus* to attack them. The damage that will be done to seed wheat by the copper-sulphate treatment for smut and by saprophytic fungi can be predicted by examination of the physical condition of the seed. All these troubles can be reduced by greater care in threshing the seed wheat so that the seed coats are not so badly broken.

According to Korstian and others in the *Journal of Agricultural Research* for May 2, 1921, chlorosis has been the most serious problem encountered in the successful production of coniferous nursery stock at a nursery in southern Idaho. The disease affects all coniferous species grown in this nursery. With chlorosis were

associated poor growth of roots, stems and leaves, failure to form normal terminal buds, and susceptibility to winter injury.

Chlorosis in western yellow pine at the Pocatello Nursery has been definitely corrected by spraying with ferrous sulphate at 10-day intervals. Similar, though less decisive, results were obtained with Douglas fir. A one per cent. solution in amounts sufficient to wet the tops thoroughly proved the most satisfactory treatment. A two per cent. solution ultimately caused chemical injury to practically all the plants. In a region of more frequent rains the stronger solution might be better.

The control of chlorosis in jack pine and western yellow pine at the Morton Nursery in Nebraska by spraying with a one per cent. solution of ferrous sulphate has given such evidence of success that it has been adopted as a part of the regular nursery practice.

"The Relation of Plant Pathology to Human Welfare" was presented by F. L. Stevens as an invitation paper at the Chicago meeting last winter and published in the *American Journal of Botany* for June, 1921. The author deals in a very interesting and convincing way with some of the achievements of plant pathology, as well as with some of the problems still to be solved. The following extracts may awaken interest and lead to a careful perusal of the entire paper:

The magnitude of the annual loss incurred in the United States alone through plant disease in diminution of yield and loss of produce is far greater than it is generally conceived to be. In 1919 the total loss with fifteen principal food products is estimated at nearly a billion and a half dollars. Among the late continental arrivals is the pine blister rust, which is under such headway that it seems to be impossible of extermination. The value of the susceptible pines is such that the loss may readily reach a hundred million dollars. The chestnut-bark disease caused a loss of $25,000,000 from 1904 to 1911. Much more serious is the loss to be borne as it invades the great chestnut forests of the Appalachians Citrus canker, imported from Japan about 1910–11, bids fair to ruin large industries. As increased long-distance communication gives intercontinental transport to disease, so congestion of crop

population creates a bridge by which the casual organism may more readily pass from plant to plant or from farm to farm. In these two conditions, facility of transportation and congestion of crop, we find, to a large degree, explanation of the fact that plant diseases are more prevalent now than formerly.

What is the nature of the return that plant pathology has given? The achievements may be summarized briefly as falling within seven great categories demonstrating the value of: protective applications, sprays and dusts; excision; seed steeps; general sanitation leading to diminution of infective material; breeding for disease resistance; modifications of agricultural practice; quarantine restrictions. Of all the categories mentioned, perhaps the least dependent upon science and the most empirical is that relative to disease resistance, since some of our most valuable resistant varieties have been given to us by farmers, while many of the most susceptible have been eliminated naturally. During recent years, however, knowledge of Mendelism and of biologic specialization has added a very important, truly scientific aspect to this somewhat empirical subject.

It is to be observed that the great discovery of the parasitism of the fungi and the founding of bacteriology and the development of its methodology, together with the early foundations laid through the years in histology, mycology, taxonomy and physiology, have furnished the bases on which plant pathology has made its advance. Aside from these there have been few, if any, great fundamental contributions. The problems of disease resistance and wherein it lies are obviously important. Enzymes and toxins will repay much study. That group of mysterious diseases including the mosaics and peach yellows holds a secret the discovery of which may well be revolutionary in pathology. But since the problems now before us are more intricate than those of the past generation, they demand concentration, larger breadth of equipment, longer periods of sustained research on a given problem, in a word, greater specialization, and this often needs to be accompanied by coöperation of widely separated branches of science or of distinct sciences.

In Research Bulletin 48 of the Agricultural Experiment Station of the University of Wisconsin, devoted to Fusarium Resistant Cabbage, Professor Jones and his co-workers summarize the present status of this important series of investigations as follows:

"It is evident that individual variation in degree of susceptibility or resistance to Fusarium has been found to occur with every variety of cabbage tested on 'yellows sick' soil. Experience to date justifies our confidence that this resistance is due to heritable differences and that, therefore, through the selection of such resistant heads from 'sick' soil, a Fusarium-resistant strain may be secured of any of the standard cabbage varieties. Our experience indicates, moreover, that through careful and repeated selection this resistance may be combined with any of the other desired qualities of the standard commercial varieties, such as season of maturity, length of stem, tenderness of leaf, shape and compactness of head. In other words, resistance does not seem to be incompatible with any other of the commonly recognized variables of the cabbage. All our experience indicates that Tisdale's conclusions relative to the flax wilt hold true for the cabbage, that resistance is probably determined by multiple factors. The degree of resistance is, therefore, due to the combination of these, and in all cases in our experience it is partial or relative, not absolute. Moreover, this explanation is consistent with our experience that after proceeding to a certain stage with our present methods of selection little or no further progress as to disease resistance is made. This is also consistent with our general experience that the best results have in each case been secured through growing a selected head in isolation and thus securing seed through self-pollination, but that when the benefits were once secured in this way with our best selections mass culture has been followed to advantage.

"Our plan of procedure, justified alike by theory and practice, is as follows. After securing a strain showing a satisfactory degree of resistance, combined with the other desired characteristics, we release it for commercial distribution. Thereafter our interest is primarily confined to such coöperation as is required for the maintenance of these essential standards. To this end we con-

tinue to grow each year a few hundred plants of each of these types in trial rows on soil that is 'sick,' *i.e.*, thoroughly infested with the cabbage Fusarium. From these plants further selections are made with the aim of maintaining the best standards both as to type and disease resistance. Of course, there is opportunity for minor gains in this way, but our experience has not indicated that much improvement is to be expected in this direction. The surplus seed thus obtained is placed in the hands of the local cabbage growers' committee for commercial increase in such manner as will best maintain general standards of excellence."

REVIEW OF KLEBAHN ON LIFE HISTORIES OF ASCOMYCETES

Haupt-und Nebenfruchtformen der Askomyzeten. Eine Darstellung eigener und der in der Literatur niedergelegten Beobachtungen über die Zusammenhänge zwischen Schlauchfruchten und Konidienfruchtformen, von Heinrich Klebahn. Erster Teil Eigene Untersuchungen, Leipsig, Verlag von Gebrüder Borntraeger, 8, 1918, pp. 395. text figs. 275.

This is one of the papers prepared for the memorial volume to Dr. Ernst Stahl in celebration of his seventieth birthday. The author is already well known for his investigations of the life histories of ascomycetes as well as rusts.

As an introduction, previous work on this subject from the Tulasne Brothers and Fuckel down is briefly reviewed. The life histories of the fungi covered in this part of the work, including about 40 species and varieties, mostly pyrenomycetes, have been determined or verified by the author. The second part, which is promised later, is to cover similar work of other investigators on this subject. This work will be of great value to all mycologists and pathologists, as the various papers which have been published on life history studies are much scattered and frequently inaccessible to students and sometimes to investigators. Most of the life histories reported are based upon pure cultures from ascospores. In many cases inoculation experiments were also made. The genus *Mycosphaerella* is taken up first and the life histories of 7 species, occurring on various hosts, are described. In some of the species *Septoria* was found to be the pycnidial stage; in others the form produced was *Phleospora*. The author suggests

that the form genera *Septoria* and *Phleospora,* though separate, are very closely related, and hence keeps their ascogenous forms together. In certain other species of *Mycosphaerella,* as *M. punctiformis, M. Fragariae* and *M. maculiformis, Ramularia* is shown to be the conidial form; while in other species, as *M. cerasella,* a *Cercospora* is produced. The author concludes, therefore, that in spite of the morphological similarity of the ascogenous forms of the various species of *Mycosphaerella* they are no more closely related than their corresponding lower spore forms. *Cercospora* is said by the author to be closely related to *Ramularia,* but is considered distinct in lacking chains of conidia and in the color of the mycelium when young. In culture *Cercospora* is said to be strikingly different from *Ramularia.* On account of these differences in the lower forms found in the species of *Mycosphaerella* studied, three new generic names are proposed: *Septorisphaerella, Ramularisphaerella* and *Cercosphaerella.*

This is an innovation in nomenclature which needs serious consideration. The purpose of these compound names is evidently to suggest at once the life history of the fungus by combining the names of the perfect and imperfect stages. In the first place this plan seems to set aside all claims of priority for previous generic names and apparently proposes the substitution of entirely new names for genera as fast as their life histories are known. This alone is a radical departure from established usage. It would also lead to frequent violation of the rule against sesquipedalian names. To be consistent in the application of this method it would be necessary to combine the names of the various form genera in cases where 3 or 4 spore stages or form genera are known to belong to the life history of a single organism. The combination of so many different generic names in one would evidently be impracticable. Supposing, however, that the plan were feasible; in the present state of uncertainty as to the types of genera and the application of generic names such combinations would be uncertain in their significance and would not mean the same thing to different mycologists. The reviewer is forced to conclude, therefore, that however laudable the author's purpose in adopting these new names, there is much more to be said against the plan than for it.

Another fact might well be considered in this connection. The author recognizes that there are species of *Mycosphaerella* which have been found to have *Ascochyta* or *Diplodina* and *Cylindrosporium* as lower spore forms, and he also finds *Phyllosticta* pycnidia present in species of his *Septorisphaerella* and *Ramulariasphaerella*. The experience of the reviewer has shown that in *Glomerella, Melanops* and other ascomycetes the same species will sometimes produce one form of conidial or pycnidial fructification and at other times another form, and occasionally two or three forms in succession in a single culture. It appears, therefore, that, in pure cultures from single ascospores, there is at present no certainty of securing all the spore forms belonging to the life history of the organism in a single culture, or in a few cultures. Sometimes no lower spore form is obtained, as the author indicates in some of his species, and he concludes as a result that the species possesses no such form. He cites in support of this conclusion the fact that in closely related rusts certain spore forms are lacking, whereas in others they are present. Evidence of this sort is entirely untrustworthy in the reviewer's opinion. It seems much more reasonable to expect that, if at one time we obtain a *Ramularia* or *Cercospora* and at another time, from the same or a very similar species, obtain a *Septoria* or *Phleospora,* both the conidial and pycnidial form may belong to both species; but for some unknown reason have not both developed in either case. Potebnia, a former worker in Klebahn's laboratory, also expresses this view in discussing *Mycosphaerella cerasella,* in which only a *Cercospora* type was produced. He says that by analogy we must assume the existence of the *Phleospora-Septoria* type in this species also. The reviewer has demonstrated (in MSS.) that such cases occur in *Melanops,* where in one series of cultures from ascospores only a *Dothiorella* is produced and in another series from the same species, so far as can be determined by morphological characters, and from the same host, only a *Sphaeropsis* or *Diplodia* spore form is produced.

It is a notorious fact that ascocarps are rarely produced in culture when the conidiospores or pycnospores are used as a starting point; but one would scarcely feel justified in concluding from

this that all of the forms behaving in this way are autonomous and have no ascospore stage. Until we know vastly more about the factors which determine the sequence and development of the various spore forms, it is futile to predict that, when cultures from ascospores produce ascocarps directly, the species lack lower forms; or that, when they produce pycnidia or conidia, this is the only lower spore form they possess.

The author very aptly remarks that there are many unknown factors yet to be determined in regard to the behavior of these organisms under cultural conditions.

The life histories of various species of *Gnomonia* follow, the author including under this genus what have been called *Ophiognomonia, Gnomoniella, Linospora* and *Hypospila.* The conidial forms of most of these species are referred to the form genera *Gloeosporium, Marssonina, Asteroma* and *Leptothyrium.* The only conclusion he is able to draw from the great variety of lower spore forms obtained is that, if the various intermediate states which occur between conidial and pycnidial fructifications are recognized, it may be said that the lower forms of *Gnomonia* all belong to the Melanconiaceae.

It seems evident that much more study and comparison of the morphological characters and the correlation of further life history studies are needed in order to determine the generic and specific relationships of the species and genera discussed.

In conclusion the author discusses and illustrates the life histories of several discomycetes, including *Entomopeziza Soraueri, Pseudopeziza ribis, P. Populi-albae* and *P. salicis.* As a result he concludes that species of *Gloeosporium, Marssonina* and *Entomosporium* are conidial conditions of these fungi, and that also species of *Gloeosporium, Marssonina* and similar fungi belong to species of *Gnomonia.* He, therefore, is of the opinion that the relation between these discomycetes and the pyrenomycetes mentioned is very close.

The reviewer believes, however, that this relation is not nearly so close as suggested, and that the author's conclusion is perhaps due to a misinterpretation of the form genera mentioned. *Gloeosporium,* for example, as used by Saccardo and others, includes a

most heterogeneous group of spore forms having only the most superficial and general characters in common, and the large number of so-called species when carefully studied morphologically and in culture are found to consist of very different organisms which should be placed in very different genera on the basis of a thorough knowledge of their morphological characters alone.

The author expresses the belief, however, that an improvement of the present taxonomy of the imperfect fungi can only be expected when their connection with their perfect stages is known. The phytopathological importance of such knowledge is also indicated, as the ascogenous form found on dead plant parts, and hence usually regarded as a saprophyte, may carry the parasite over winter and be the source of new and unsuspected infections in the spring.

As to which was the primitive spore form, he says: "Little is known as to whether the original form of fructification was ascogenous or conidial." Brefeld's views regarding the relation of asci to sporangia he does not consider tenable in the light of our present knowledge. The evidence thus far accumulated by the author and others would seem to justify the belief that further studies of the life histories of the ascomycetes and of the morphological and cultural characters of the various spore forms or stages will furnish most important clues to the taxonomy and phylogeny of this great group of fungi and make it possible to present a more natural system of classification than we have at present.

The numerous clear text figures given are indispensable in interpreting the work and getting exact ideas of the forms discussed. The text is less involved and more easily read than that of many German scientific writers. It is to be hoped that the author will continue these valuable studies and that the second part of the work may soon appear.

C. L. SHEAR

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